AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

SEPTEMBER 1935

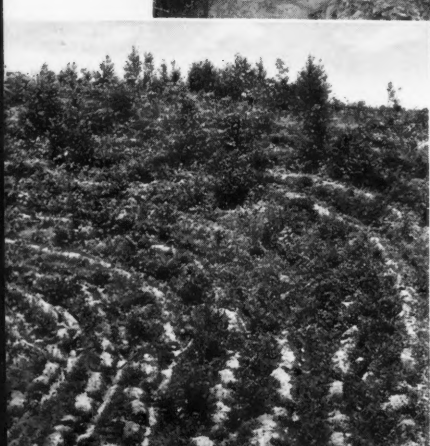
VOL 16 NO 9

ASAE

Case Plow in use on U. S. Forest Service Project.

A Contribution to Forest Conservation

Plenty of room for worker and seedling in the furrow from this big forest plow.



Note the rocks as well as the growth and topography amid which these furrows were made.

This new Case Plow is designed to do well many types of forest work . . . making fire lanes or running emergency fire lines, furrowing for seedlings and all other heavy plow jobs. It is made to follow through anywhere that a tractor can go. Being unusually narrow and compact, it has ample clearance even when swinging in on curves. Its two large wheels with broad, heavy tires will stand tough going.

With operator on the rear platform, there is plenty of weight to hold the big bottom to its work. From this vantage point he adjusts the screw-type bottom lift with the big hand-wheel. Without slowing down he makes every desired setting for furrow depth, or spins the plow out of the ground to ample clearance. The flexible hitch can be made stiff for transportation.

The dust-proof rolling coulter, made of heat-treated steel and reinforced by malleable hubs, is more than a coulter. It serves as a guardwheel protecting the plow point from roots and rocks. Like the wheels, the coulter has removable bushing and pressure gun lubrication.

The plow share is of crucible steel. The moldboard, of soft-center steel, combines toughness with good scouring. There is a wear-resisting (chilled) slip-heel on the landside, and a moldboard extension.

We invite you to get acquainted with this plow. Write for complete specifications. J. I. CASE COMPANY, RACINE, WIS.

CASE

AGRICULTURAL ENGINEERING

Published by the American Society of Agricultural Engineers

Volume 16 | SEPTEMBER 1935 | Number 9

CONTENTS

Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cent a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .

The MINNEAPOLIS-MOLINE two row picker-husker shown with their model "KT" Tractor—both Hyatt equipped. An ideal corn harvesting combination freed from bearing wear and care.

AGRICULTURAL ENGINEERING

VOL 16, NO 9 EDITORIALS SEPTEMBER 1935

Farm Electricity Needs Selling

AMONG the maze of statistical and other data presented by Dr. E. A. White in his twelfth annual report as director of the Committee on the Relation of Electricity to Agriculture, an important principle seems to emerge. Having electricity is not entirely, probably not even mainly, a matter of accessibility, economic utility, and adequate income. Intensity of desire is as potent as any—perhaps all—of these.

How else can we account for 55 per cent of the non-farm rural population being served with electricity, while only 10 per cent of the farm population is so served? ("Rural," as here used, means outside incorporated places of any size whatsoever.) No doubt many of these non-farm rural people live in suburban fringes, closer to city or village power lines, but without rate advantage over farm people. Some of them are estate owners; many more of them live in shacks. Economics and geography are not enough to account for the 5.5 to 1 ratio.

After allowance for all the complicating and compensating factors, proximity to the city or participation in its affairs works its effect on the non-farm rural use of electricity not through technical and economic, but through psychological channels. Urban-minded people simply take electricity for granted as a necessity. Farm people, for the most part, do not.

Correlating electric service with the motor car leads to the same conclusion. Admitting that the farm family must have means of personal transportation as a counterpart to the street car, it is obvious that the luxury increment in the farm automobile—meaning greater first cost, frequency of replacement, and annual mileage than is reasonably necessary—takes priority over electric service. The city family will do without a car and have electricity; the farm family will not defer car replacement a year or two to get electricity.

Speeding up farm electrification therefore resolves itself into a sales job. As engineers we are creating more uses or values to be sold. We are steadily reducing the net price (especially if earnings are credited) of electricity. We are even, by extension and other educational measures, doing a fair job of selling. For engineers we are pretty good salesmen.

Yet it seems logical to suggest more sales effort by the power and equipment interests. The first step may well be that of restoring to full strength the CREA, both the national body and its state subsidiaries. Next should come coordinated advertising and sales solicitation to keep farm people electricity-conscious and develop desire en masse to the action-point. Educational and promotional work by governmental agencies is helpful but not enough for rapid commercial progress. It took more than public encouragement to put over the automobile, the radio, bus transportation, and mechanical refrigeration. They did not wait to be coaxed by the customers. Each was aggressively sold by the interests who had it to sell.

In thus urging that a larger burden of specific sales effort be borne by other shoulders, we do not shirk responsibility. With expanded sales our work will increase along distinctly engineering lines. Meanwhile we must continue, with more rather than less emphasis, to double as salesmen.

Electricity in Plant Husbandry

BOTH ELECTRIC light and electric heat have established their places in the distinctly agricultural applications of electricity, but for the most part their use has been separate. True, electric lamps have been used to some extent as sources of heat in chick brooders, but such lamps as have seemed economically feasible for heat sources have not been very significant in their contribution of biologically effective light, and vice versa.

Studies reported by the Boyce-Thompson Institute on the use of lamps for both heat and light in a highly insulated, astronomically designed greenhouse seem to hold great promise. Solar energy, both as heat and light, is utilized to a high degree. Heat losses during the dark hours are reduced to a point consistent with the economics of electric heat. It seems proper to inquire whether bright metal foil insulation can be used to screen off much of the radiant heat loss which otherwise occurs through the glass, and at the same time increase somewhat the efficiency with which the light component of the lamp energy is used.

Plant scientists rather than engineers must explore fully the results which may be secured from supplemental lighting. It appears that the increment to the total light energy available for photo-synthesis is unimportant in comparison with the effects of an altered time ratio of light to darkness on the habits of the plant. Leaving the intensity and duration of supplemental lighting, and its composition also, to the plant expert, there will be plenty of work for the engineer in devising set-ups to meet efficiently the job requirements so laid down.

Similar possibilities and problems are implied in the results reported by Professor H. B. Walker from California, in which tomatoes are made to yield from ten to forty times as heavily as under field conditions, and some other crops have multiplied their outturn almost as amazingly. Nutrient solutions rather than soil furnish the feeding ground for roots, with solution held at optimum temperature by electric heat and thermostatic control. How much of economic feasibility may come from these fascinating developments depends on the efficiency which the engineer can contribute to the use of energy and equipment.

Farfetched as some of these things may seem to the "practical" mind, they warn us against easy concurrence in the claims that agriculture can "never" make economic use of large volumes of low-cost power. If history continues to repeat itself, the wildest dreams of the visionary are likely to fall short of attained reality.

Engineered Agriculture Is Stabilized Agriculture

BECAUSE of the extent to which electric power is used in irrigation, especially supplemental irrigation in normally humid areas, farm electrification exemplifies well the broad truth that engineering is steadily adding stability to agriculture. Irrigation of arid regions overcomes climate; supplemental irrigation minimizes the vagaries of weather. The combine, at first considered subject to the mercies of climate, is becoming more and more its master.

Tractor power to meet adverse conditions, terracing to control soil erosion, crop drying, climatic barn design, and a host of other items in the subject matter of agricultural engineering are steadily writing down the limitations and hazards of weather and climate. Valuable as this is to agriculture, it is even more vital to the national well-being.

As food production concentrates more and more into the hands of an ever smaller minority of the population, the greater the hazard of hardship to the non-agricultural population if natural causes disturb the continuity of crop yield. Thanks to the productiveness of modern agriculture, the threat of famine seems remote. But we have recent and ample evidence that excess, or seeming excess, of production can create widespread hardship as could shortage. Stabilization by engineering can escape the curse of both extremes, and at the same time avoid the difficulties of arbitrary control.

Being inherently efficient, in that it makes for continuous operation of our farm plant at normal capacity, stability by engineering brings us closer to those seeming incompatibles—high income for the farmer, and low costs for consumers. Because of the large part which electricity seems destined to play in stabilizing production, a far-sighted nation will not begrudge the cost of substantial encouragement to farm electrification, and to research for widening its applications.

Curved Fences for Contours

IN SUCH COMMENT as has come to our attention since these columns last month proposed more engineering attention to farm fences it has been assumed, if not declared, that fences along terraces or other contour lines must necessarily consist of straight runs joined by angles at which suitable bracing must be provided. Better methods and greater economy in bracing have been mentioned, but not the possibility of its avoidance.

A series of tangents roughly approximating the curve of a contour leaves much to be desired. Either the fence row must be wastefully wide, or farming operations, supposedly following the contours smoothly, must be similarly angular. Bracing of the conventional sort, to be most economical of material, would bisect the angles and extend as a menace to machinery. Diagonal braces presumably would be located for thrust rather than tension; if so would have to be either excessively long or used in connection with well-anchored posts.

We make bold to challenge the whole assumption, and to propose the possibility of posts each so well braced with wing anchors as to carry in itself the relatively small component of force set up at a single post in a continuously curved fence. If, as is done with some bracing systems commercially sold, it is possible to carry about half of the total tension of a fence on a rather small steel anchor driven into undisturbed soil, it may well be feasible to add sufficient anchorage to line posts without undue cost or difficulty in driving or setting.

For a given combination of post, soil, and fence tension there would be a limiting angle; this in turn implies a post spacing that varies with the curvature of the contour. Stretching fence around curves also will present difficulties to be overcome. Indeed, the whole matter of what is optimum tension for a fence needs engineering examination. There is plenty of work to be done before the erected fence assumes a place of dignity as an engineered structure. The sooner this work is begun and the more aggressively it is pursued, the more help it will be in the long over-due fence rehabilitation of America.—W. B. JONES

"For Fence Engineering"

To the Editor:

I HAVE just read your timely editorial in the August number of AGRICULTURAL ENGINEERING, entitled "For Fence Engineering."

This is indeed timely from my standpoint, since I have recently returned from a field trip visiting some of the soil erosion projects, and the need for a properly constructed fence approximately following the contours was quite forcibly brought to my attention.

Contour farming, which is being recommended very strongly in practically all instances by the Soil Conservation Service, requires in many cases the division of fields on the contour. A practical fence under such conditions would consist of tangent lines with proper bracing at all points where the direction of the lines change. Bracing of course increases the cost of fencing, so that in developing a properly braced fence under such conditions low cost together with effective methods of bracing should be duly considered.

C. E. RAMSER

Senior drainage engineer
In charge, watershed and engineering studies
U. S. Soil Conservation Service

(EDITOR'S NOTE: The editorial on this page, entitled "Curved Fences for Contours," was prompted by the need for the particular kind of fence engineering outlined in Mr. Ramser's letter. It presents indeed an interesting problem for agricultural engineers.)

John Johnston—The Father of Tile Drainage in America

By B. B. Robb[1]

AS IT IS NOW just one hundred years since tile drains were first laid in America, interest is again called to the John Johnston farm where this historic event occurred. Probably the finest article ever written about John Johnston and his farm was that from the pen of Dr. L. H. Bailey, published in *American Gardening* for March 1893. At that time Dr. Bailey was dean of the New York State College of Agriculture at Cornell University and much interested in the Johnston Farm. With the permission of the author and the publisher the article follows:

JOHN JOHNSTON, 1791-1890

"In the picturesque lake country of western New York, sloping up from the shores of Seneca Lake, and in full view of the snug little city of Geneva, across the water, lies a farm which must always remain a historical spot, for upon it the first drain tiles were laid in America. It seems strange now, as we think of it, when tile-draining is an accepted practice, that the beginning of such an important movement should have been so recent. It was in 1835 that John Johnston, a sturdy and enterprising Scotchman, imported from Scotland a few drain-tiles to lay in the 'cold, wet, clayey soil' of this western New York farm. Fourteen years before, in 1821, John Johnston, then a man thirty years old, had come from Scotland, and had bought this farm, which was even then said to be worn and poor. He had ridden on the top of a vehicle in going from his home to the seaport, and at night he had spied a fire burning in the fields. He asked the driver the reason for the fire. 'Oh, the fools are burning crockery to put in the ground,' he replied. But Johnston was alert, and made further inquiries; and his interest bore good fruit in after years. But young Johnston seems to have had earlier lessons in draining than this, although apparently not with tiles. 'Verily all the airth needs draining,' his grandfather had told him, and Johnston once said years after, to a friend, 'Whatever I know of farming I learned from my grandfather.' Later, when he saw that his land was cold and backward, he considered the grandfather's opinion and the crockery which was burning in the Scotch fields. He resolved to try tile-drains! Of course the neighbors would laugh at him, and wiseacres would predict his doom. But they had done this before, and Johnston did not care. He had made up his mind; he should try. He ordered some tiles from Scotland. They reached New York harbor on the night of the memorable fire of 1835, and Johnston was much concerned, for fear that the ship had burned and the tiles were lost. But they reached him safely—a small pile of the heavy, open-bottom horseshoe tile. Then what a curious lot of on-lookers came to see them! Here was something new under the sun, and everybody was incredulous! How could the water get into them? How could it ovecome the pressure of air at the outlet? They would freeze. They would crush. They might poison the land. They would draw the water all to one place, and make that place wet. They would dry out the land in the summer. One can imagine the objections and the wise comments. But John Johnston buried his crockery in the ground out of sight, nevertheless!

"The experiment was a success, and he sent to Scotland for patterns and had tiles made by hand. In 1848, a neighbor, John Delafield, imported a Scraggs' tile machine from England, and from that time on tile-draining progressed rapidly. In 1851 Johnston had laid sixteen miles of tile on his own farm, and in 1856 there were over fifty-one miles! He used the horseshoe tiles to the last, and did not favor deep ditches. Ditches two to two and one-half feet deep, and laid as close as twenty feet apart, were his ideal. Theron G. Yeomans, at Walworth, in an adjoining county, was soon attracted to Johnston's success, and these three men — Johnston, Delafield, and Yeomans — assiduously spread the gospel of tile-drains. Robert Swan, an intelligent and wealthy man, was also attracted by this new farming; for a time he lived with Johnston, and married one of his daughters. He bought the adjoining farm, Rose Hill, which had long been known for its beauty and fertility, and there consummated the first consecutive and ideal system of farm drainage in this country. Johnston had done his draining by piecemeal, feeling his way carefully, and often waiting for the increased returns from crops on the newly-drained lands before proceeding farther. But Swan planned and carried to completion an extensive and homogeneous system. Rose Hill became renowned for its splendid achievements and the beauty of its fields and buildings; and it yet remains the finest example upon the continent, probably, of the palatial farm homes of the last generation. The impulse of all this experiment was after a while felt throughout the county. A neighboring farmer, writing in 1866, declared that he was going to build a barn 'after my land is drained and I have had two or three of John Johnston's wheat crops.' The Johnston farm and Rose Hill, both still productive and beautiful, are together perhaps the most important spot in American agriculture.

"The clay farm began rapidly to improve with the laying of the tiles. In fact, the draining is said to have paid for itself as it progressed. The wheat, which was always John Johnston's leading crop, jumped at once from the indifferent yields of fifteen and twenty bushels to over thirty and often over forty bushels. But this gain was not all due to tile-draining. John Johnston was a good farmer in every direction. He believed in excellent preparation and liberal manuring. Sheep were great favorites with him, often quite as much for their manure as for their flesh and wool, and he found most money in feeding them when grain was high, because competition was less.

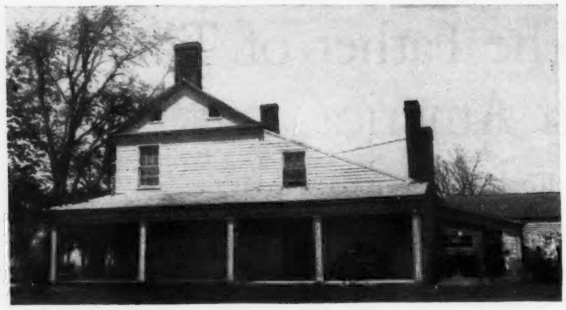
"The old homestead, which was built in 1822, still stands upon a sunny corner, screened by locusts. There are many curious nooks and crannies inside, and in one of the larger rooms is a Franklin fireplace, which was early brought from Virginia by Mr. Rose and sold to John Johnston in 1834. The barns stand across the highway, against the roadside.

"The old farm and the country are fortunate in finding an owner who is fully alive to the value of his charge. The estate is now owned by Charles Rose Mellen, a connection of the early occupants of Rose Hill, and no man could be prouder of his possessions. He lives in the old homestead, and crops the fields in the most approved methods. The drains are all in perfect condition, and the fields are still as productive as ever. Last summer he showed me a field from which, the year before, he had harvested an average of over forty-two bushels of wheat per acre; and the oat field across the way was a miniature forest shoulder high. Below the house, next to Rose Hill farm, a broad pasture with trees here and there, contained flocks of sheep, as it did, no doubt, a generation ago. 'Young man,' said a neighbor recently to Mr. Mellen, as he admired the winter lambs, 'I don't give you a bit of credit for these fine, healthy sheep; it is the pure spring water you give them, and the high, dry, underdrained farm.' 'Perhaps he was right,' Mr. Mellen said to me; 'at any rate, he spoke a good word for the dear old farm.'

"John Johnston was tall and spare, with intellectual and striking features. He gave the closest personal attention to all the details of his farming from 1821 to 1877, when the infirmities of age made it necessary for him to rent the farm. He died in Geneva, in November, 1880, in his ninetieth year.

"The late Joseph Harris was always a warm friend and ardent

[1]Professor of agricultural engineering, New York State College of Agriculture at Cornell University. Mem. ASAE.



View from the south of the old Johnston homestead near Geneva, N. Y.

admirer of John Johnston, and a few sketches from his pen will portray the character of this sturdy pioneer: 'John Johnston talked of giving up farming (1868). He was over eighty years old and had no son, help scarce and not trusty. Had I not better sell? he asked. I wrote him, No. Fancy John Johnston in a city! No underdrains, no growing of crops of grass and clover, no wheat, no corn, no barley, no sheep! The last time I was there, when he went into the field, his favorite cows came to be patted, and a splendid heifer calf put her nose into his arms. Shall he leave them? Those who say so know nothing of the pleasures of farming. He now writes me: The farm is not to be sold. I have let forty acres for five years for nursery purposes, at a yearly rental of $1,000, payable semi-annually. This is a great deal better for me than selling. It would have been a great trial to have left my farm. I still have over fifty acres of cleared land, and you may be sure I will do my best with it. I have sold this year's crop of wheat for over $1,500. I have 900 bushels of ears of corn from a trifle over eleven acres, and at least seventy tons of hay. I have bought 300 wether sheep and ten tons of oil-cake. Won't I make manure for my small farm! . . . . . Twenty-five dollars per acre rent (5 per cent on $500 per acre) is not a bad price for a farm which was once said to be the poorest land in creation. So much for thorough underdraining, good tillage, liberal feeding, and high manuring!

"'I have visited John Johnston a great many times, and wish every young farmer in the country could enjoy the same privilege. He is so delightfully enthusiastic, believes so thoroughly in good farming, and has been so eminently successful, that a day spent in his company cannot fail to encourage any farmer to renewed efforts in improving his soil.'

"So John Johnston lived—upright, energetic, and a pioneer! His memory will grace our history."

John Johnston was not only one of the best farmers of his day, he was active in the agricultural organizations of the time, taking a prominent part in their meetings and he wrote many articles for publication, many of which had to do with his experiments with tile drainage which attracted much attention among the outstanding farmers of the time. To give an idea of the clear thinking of Johnston and how well he understood the principles of land drainage, it is interesting to read a paper presented by him before the New York State Agricultural Society and published in the proceedings of that organization in 1851, for which he was awarded a silver cup. The paper follows:

EXPERIMENTS IN DRAINING

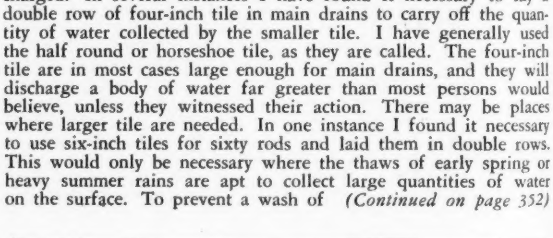
By John Johnston, of Seneca County, N. Y.

"To the Executive Committee of the
New York State Agricultural Society:

"In your list of premiums presented to the farmers of this state for competition at the winter meeting in January next, a premium is offered for experiments in draining.

"Having long esteemed a good system of drainage as important to good farming, and being well convinced that it would much increase the profits on most farms, I have made tile drains on my farm in Seneca County, extending to full sixteen miles in length. The farm is situated on the rich clay ridge which extends from the Seneca River southerly to Tompkins County, a ridge of land devoted chiefly to the cultivation of wheat. I was many years ago satisfied of the necessity of removing in some economical way the surplus water which saturated the soil, and too often interfered with the growth or maturity of the crop, not only the wheat, but also with other grain and clover. My first efforts, for more perfect drainage, were made in 1835, when I imported a pattern of drain tile from Scotland, and caused them to be made in this neighborhood by hand labor. But it was not until 1839-40, that I felt encouraged by success, as the labor and cost were too great to warrant extensive use; such tiles as were used by me gave satisfactory evidence of their value. The important changes effected on portions of my farm were noticed by your present presiding officer, and so thoroughly convinced him of their utility and necessity of drainage that in 1848 he imported a machine for making drain tiles in this county. From that day the expense or cost has been reduced, that no excuse exists for wet fields or grain being destroyed by freezing out. From that day I have continued to construct drains as fast as my proper farm labor would permit, and present to you the results thus far obtained. The question as to the depth of drains has always been one of interest, and some uncertainty. On this point, I deem it absurd to propose any fixed rules, as the depth must depend upon the formation of the land and nature of the soil. The rule adopted by me is first to select a good outlet for the water, then to dig a ditch so deep as to find a hard bottom on which to lay the tile; yet I have laid many tiles on clay, and they have done well. On my farm this depth is generally found at two and a half to three feet in depth, and I believe no drains ought to be less than two and a half feet in depth. The distance between the drains is regulated by the character of the soil; if it is open or porous, drains three or four rods apart may thoroughly drain it, while on more tenacious soils, two rods apart may be needed. In most cases, where my fields lay nearly level, it has been found necessary to construct the drains nearer to each other, adopting as a rule that the drains should always reach the point of the field where water is indicated to rise, and that is always at or near the highest part of the field, although that may only be observed when there is much water in the earth, and the springs full, or when the field is in wheat or clover. At such elevations, I put my drains deeper and nearer each other to make sure to keep the water all under ground, using smaller tile leading to the main or submain drains.

"This rule has been important, for when opening ditches on the low grounds, the water has flowed with a force to induce most people to believe that it was derived from springs close by, when possibly the spring may be some 60 or 80 rods distant at or near the most elevated part of the field, which, when reached, may save much expense in draining the lower lands. This shows the necessity of thoroughly examining the land to be drained in the wettest season. The main drains occupy the valleys or lowest grounds, receiving the lateral drains and collected water. They are constructed of larger tiles, and discretion and care are very necessary to apportion the main drains to the quantity of water to be discharged. In several instances I have found it necessary to lay a double row of four-inch tile in main drains to carry off the quantity of water collected by the smaller tile. I have generally used the half round or horseshoe tile, as they are called. The four-inch tile are in most cases large enough for main drains, and they will discharge a body of water far greater than most persons would believe, unless they witnessed their action. There may be places where larger tile are needed. In one instance I found it necessary to use six-inch tiles for sixty rods and laid them in double rows. This would only be necessary where the thaws of early spring or heavy summer rains are apt to collect large quantities of water on the surface. To prevent a wash of *(Continued on page 352)*



The silver pitcher and goblets presented to John Johnston on Christmas 1859 by Henry S. Olcott of the New York "Tribune" and twenty-one other admirers in recognition of his outstanding service to agriculture

The First American Drainage Engineer[1]

By John R. Haswell[2]

THE YEAR 1935, as far as we can tell, marks the 100th anniversary of the laying of the first drain tile in the United States. As many of the members of the American Society of Agricultural Engineers began their professional careers with tile drainage, or are interested in the work, it seems fitting to honor the man, Mr. John Johnston, who brought the idea to America.

John Johnston was a Scotchman born in New Galloway in 1791. The general necessity for drainage was impressed on him very early in life by his grandfather in Scotland who said to him: "Verily all the airth needs draining." He was only a small child when Joseph Elkington of Warwickshire, England, was awarded 1000 pounds by Parliament for his discoveries and applications of the method of land drainage given his name. The Elkington system consists of boring auger holes in the bottom of deep ditches to tap hidden springs. He had the gift of locating the water under pressure, and as soon as a passage was opened it rose and drained off in the open ditches. He drained his own farm in 1764. The use of this system in connection with tile drains has not been noted in England or Scotland where Elkington operated, but it has been practiced in draining irrigated lands in the West and has been used occasionally in reaching deep spring water with tile which was laid too shallow.

The story is told that, as a young man travelling to the sea coast to embark for America, Johnston saw one evening his first tile kiln burning brightly. Upon inquiry as to what it was he was told that it was burning material for the new-fangled idea of putting crockery pipes into the ground. We do not know how true the story is, as he was 30 years old when he emigrated in 1821. He had married in 1818. However, he must have had some knowledge of tile drainage in the old country, for he sent back for some tile. The first tile used in England were installed in 1810, but the idea did not spread until about 1840, and in 1843 the first machine for moulding cylindrical tile was perfected. That Johnston kept in touch with developments in his native land is well brought out by later facts.

John Johnston bought his now famous farm on the east shore of Seneca Lake on the Geneva-Willard road, Seneca County, New York, in 1821. He said in 1852, "I was many years ago satisfied of the necessity of removing, in some economical way, the surplus water which saturated the soil and too often interfered with the growth or maturity of the crop; not only with wheat, but also with grain and clover."

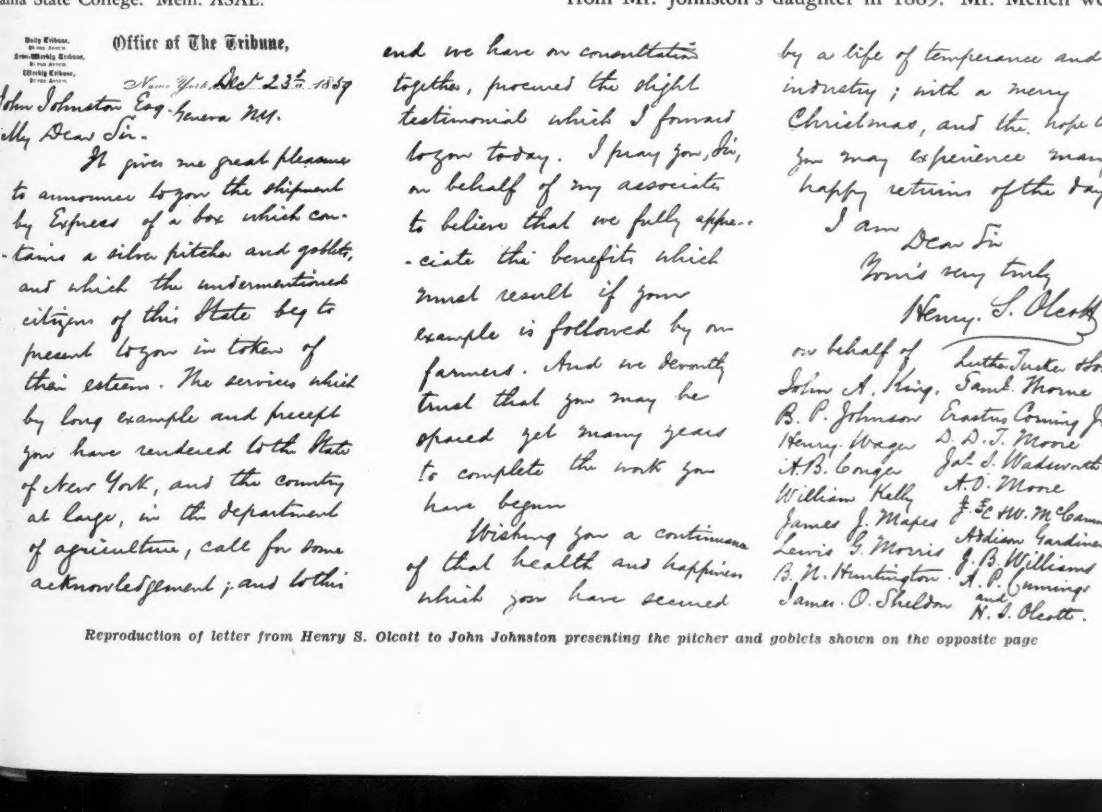
When he found the soil on his farm, which lays on a high ridge, to be "cold and wet" he imported in 1835 a few tile from Scotland and initiated the making of others by hand. (The date of the first tile laid in America has been placed by some as 1837, and Johnston's writings are quoted as 1838, but the latter seems a typographical error. The *American Agriculturist* for April 1874 gives 1835.)

He persuaded his neighbor John Delafield to import a Scraggs tile machine from England in 1848. The first tile were of the horseshoe and sole type later changing to round tile. He is reported to have laid practically all the tile with his own hands in ditches dug with ordinary labor from his farm.

Much of the foregoing account is taken from a paper presented by the late Mr. Charles R. Mellen before the New York State Drainage Association in 1912. At that time he owned the Johnston farm which he had bought from Mr. Johnston's daughter in 1889. Mr. Mellen went

[1]A portion of the author's address as Chairman of the North Atlantic Section of the American Society of Agricultural Engineers at the meeting of the Section held at Harrisburg, Pa., January 1934.

[2]Professor of agricultural engineering extension, The Pennsylvania State College. Mem. ASAE.



Daily Tribune. Semi-Weekly Tribune. Weekly Tribune.

Office of The Tribune,

New York Dec^r 23^d 1859

John Johnston Esq. Geneva N.Y.

My Dear Sir.

It gives me great pleasure to announce to you the shipment by Express of a box which contains a silver pitcher and goblets, and which the undermentioned citizens of this State beg to present to you in token of their esteem. The services which by long example and precept you have rendered to the State of New York, and the country at large, in the department of agriculture, call for some acknowledgement; and to this end we have in consultation together, procured the slight testimonial which I forward to you today. I pray you, Sir, on behalf of my associates to believe that we fully appreciate the benefits which must result if your example is followed by our farmers. And we devoutly trust that you may be spared yet many years to complete the work you have begun.

Wishing you a continuance of that health and happiness which you have secured by a life of temperance and industry; with a merry Christmas, and the hope that you may experience many happy returns of the day.

I am Dear Sir
Yours very truly
Henry S. Olcott

on behalf of
John A. King, Luther Tucker Hon
B. P. Johnson, Saml. Thorne
Henry Wager, Erastus Corning Jr
A. B. Conger, D. D. T. Moore
William Kelly, Jas. S. Wadsworth
James J. Mapes, A. O. Moore
Lewis G. Morris, J. & C. W. McCammon
B. N. Huntington, Addison Gardiner
James O. Sheldon, J. B. Williams
A. P. Cummings
and H. S. Olcott.

Reproduction of letter from Henry S. Olcott to John Johnston presenting the pitcher and goblets shown on the opposite page

on to say: "In the fifties and sixties, Mr. Johnston made good on the old farm. In 1851 he had sixteen miles of tile laid and in 1856 there were fifty-one miles on the farm. At his death in 1880, when in his ninetieth year, there were seventy-two miles. He raised premium crops of wheat, oats, and barley, and always had good cattle and sheep. He was especially fond of sheep for he said the manure from the sheep sheds was the best. In 1859 he received a silver pitcher and goblets from a few prominent men who maintained that he had been of great service to the age and to the state. In 1895 I had a piece of wheat on one of the fields that for over sixty years had been cropped and pastured and moved by Mr. Johnston many times.

"Mr. Johnston was widely known as an authority on draining and in 1852 was awarded first prize by the New York State Agricultural Society for a paper giving an account of his methods and results in tile draining. For some years he was chairman of the Committee on Drainage of the New York State Agricultural Society. Well do I remember Mr. John Johnston, tall and erect, with hair as white as snow, a man noticed anywhere."

A number of good yields were then noted and the poor condition of neighboring land described. While I have always been prone to advocate the more random systems of intercepting drains and have proclaimed "drain the wet spots in good fields," I have seen many places where uniform drainage has produced good returns on the investment. Mr. Mellen described the farm and drainage system as follows:

"It is rolling land and the casual observer would think such a thing as underdraining would be superfluous and unnecessary. This is where Mr. Johnston showed his wisdom, for uplands and all were drained (the soil is a rich, calcareous clay), and on the next farm, owned by Mr. Swan (Mr. Johnston's son-in-law), the hills proved to be wetter than the valleys, so that after the lower work was done, it was found necessary to put in other drains on the hills. They are now about sixty-seven feet apart on the high land and fifty-four feet apart on the low land and two and one-half to six feet deep. Only a few years ago a man who came to see the old farm remarked, 'You say this farm is underdrained, of course you mean the lowlands; the hillside here certainly has natural drainage sufficient without tile.' Mr. Johnston maintained he never made any money farming until he had drained his land and there are about seventy miles on the 300 acres."

John Johnston—The Father of Tile Drainage in America

(Continued from page 350)

the surface in such places, I have at regular distances filled the ditch directly over the tiles with small stones for a length of from 12 to 18 inches, the stones to rise a little above the surface to prevent the covering of the stones by the plow; through these stones the surface water will pass rapidly down into the tiles and be carried off at once. When the tiles are laid in the ditches with regularity and care, the earth is thrown in by a plow having a doubletree 9½ feet long to enable a horse to go on each side of the ditch, which is a rapid and economical way of filling them. In regard to cost, I find that drains constructed with two-inch tiles can be finished complete for 30 cents per rod, yet something must depend on the digging, whether the earth be hard or soft and the distance to draw the tiles; mine have all been drawn five miles, and I find that two-inch tile are large enough, except for main and sub-main drains. In my own case, I was compelled to feel my own way and discover the best system and best adaptation to my lands; consequently the drains have cost me more than they would if I were to construct them with my present experience.

"In order to show the benefits derived by me, the following remarks will be necessary—to me the results are very satisfactory and conclusive. My farm is on the east side of Seneca Lake, opposite to Geneva, and immediately adjoining the farm of your honorable President, John Delafield, Esq. About six years ago I began to drain a field on the boundary line between Mr. Delafield and myself; the field contains about 20 acres, of which six were then subject to drainage; the six acres had seldom given a remunerating crop, even of grass; after draining the six acres, the whole field was plowed and prepared for corn, two acres being reserved for potatoes. The usual care was given to the cultivation of the whole crop, which, during its growth, showed a marked difference between the drained and undrained portions of the field; the yield of this field proved to be the largest ever raised, as I believe, in the county, the product being eighty-three bushels and over per acre; when the corn was husked and housed, it was weighed and measured in the ear, and allowing seventy-five pounds to the bushel, as has been customary in this region, for corn and cob, the product was as above stated. This field attracted much attention from my neighbors and other gentlemen from more distant places; it was examined at the time of draining, and after plowing, both the first and second season, permitting the parties to walk on the drained parts, without any undue moisture, while all other undrained land in the neighborhood was muddy, and, as before stated, the corn was found to be far more vigorous in the plant and abundant in the grain. In the following season after the corn, I cropped it with barley and found the drained land produced altogether the finest plant and the best yield of grain; when the barley was harvested, I prepared the field and cropped it with wheat. The difference again was so striking and distinct in favor of the drained land, that I felt the propriety of thoroughly draining the whole field, which was completed without loss of time at a cost of twenty-two dollars per acre for the whole field. I then plowed and sowed with barley and seeded with clover; of the latter I cut a very large crop last summer, and not one square foot of the clover froze out, and now I can rely on a good crop of anything I may sow or plant. I had previously drained several other fields, or at least those parts that needed drains. Encouraged by a considerable increase of products derived from my farm from draining, I determined to extend the system as rapidly as convenience and circumstances would permit. Upon examination, It appeared necessary to possess a piece of ground belonging to a neighbor, that I might secure a good and sure outlet for the water from some of my upland fields that required draining in places. With this view I purchased 10.6 acres of low land, saturated with water. A part of this land, say, about four acres, from twelve to eighteen inches of the surface was a black vegetable mould lying on a stratum of clay of the same depth, under which I found a hard bottom for my tiles, not over three feet in depth; I felt persuaded that those ten acres were wet from my own upland, as well as from my neighbor's wet land adjoining. The first ditch I dug was directly on the line betwixt the land I got of my neighbor, and that he still owns. This I found cut off all the water on that side. I then commenced draining that 10.6 acres; also about thirty acres of upland; a large proportion of the upland did not require draining. In the two pieces, made into one field containing about forty acres, I laid 1,072.5 rods of drain which have drained the whole extent in a thorough manner. The flow of water was so large at times, I was compelled to use a large number of the largest sized tiles, and for main drains, as I had to have three, I had to lay double rows of four-inch tiles, and in one locality I had to use a double row of six-inch tiles for over fifty rods; this received a great flow of water from a public road which was let into the tiles by digging a basin at the upper end of the drain, and then filling with small stones over the tiles. These extra sized tiles increased the expense of these drains, making 1,072.5 rods, to cost about 40 cents per rod. The first year after completing the drains on this field, the whole or nearly the whole, upland and all, was planted with corn; the season was not favorable for that crop in this neighborhood, yet the crop was fair, say, full 40 bushels shelled corn to the acre; the low ground was excellent, where nothing but coarse grass grew for twenty years before. This year, 1851, I harvested from this field a crop of wheat, and a heavier crop I never saw stand up. Heretofore many acres of wheat were lost on the upland by freezing out, and none would grow on the lowlands. Now there is no loss from that cause, only two small patches, in all less than one quarter of an acre was lodged; in fact, the whole field was so even that it was difficult to pronounce any five acres worse than the rest. The wheat fly injured it a little, but I think not a great deal; I have not yet thrashed enough to know the yield of wheat per acre. The wet ground got from my neighbor was the source of much curiosity to all around, as none would believe wheat could be ripened on land so long saturated with water. It *(Continued on page 355)*

Electric Heat for Propagating Benches

By J. R. Tavernetti[1]

ELECTRICITY, having proven beneficial and economical, is commonly used as a source of heat in warming propagating beds. The common practice is to install 60 lineal feet of standard soil-heating cable in each 36 square feet of bed, giving a connected load of approximately 11 watts per square foot. Since, however, the propagation of different plants requires different temperatures, ranging from 50 to 80 degrees (Fahrenheit), and since the heat loss is less when the bed is covered than when it is uncovered, 11 watts per square foot is not satisfactory and economical for all installations. When a relatively high temperature is to be maintained in an uncovered bed, 11 watts is insufficient; when a relatively low temperature is to be maintained in a covered bed, it is too great. Although in the latter case the bed will operate satisfactorily with thermostatic control, the size of the bed could be increased without additional cost for electrical equipment. The data presented in this paper were obtained from experiments conducted to determine the connected load necessary in a propagating bed under different conditions.

The experiments were conducted in a room where the air temperature was maintained between 40 and 44 degrees. The bench (Fig. 1) was 4 feet wide and 7½ feet long and contained 8 inches of sand such as is used for propagating cuttings. In this sand 50 feet of soil-heating cable was placed 6 inches below the surface and 2 inches above the bottom. The cable was laid in hairpin loops running the length of the bed, with 8 inches between the legs of the loop. Resistance thermometers placed at various points in the sand, together with thermocouples embedded in the lead sheath of the cable, indicated the temperatures. Glass sash were used for covers, and pieces of soil-heating cable were connected in series with that in the bed to vary the connected load.

Four series of experiments were run: (1) one with dry sand in the bed and no cover, (2) one with dry sand and the bed covered, (3) one with wet sand and no cover, and (4) one with wet sand and the bed covered. In each series of experiments five runs were made with various quantities of heat per square foot of bed. In each run the heat was on continuously, and the temperature became constant before the readings were taken. The dry sand contained about 0.2 per cent moisture; the wet sand from 6.0 to 6.5 per cent.

An air temperature of 40 to 44 degrees surrounding

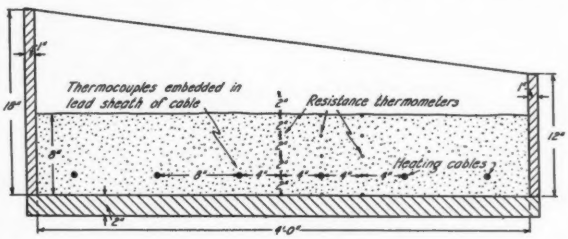


Fig. 1 Cross section of the propagating bench showing the location of heating cable and the temperature indicators

[1]Associate in agricultural engineering, University of California; field engineer, California Committee on the Relation of Electricity to Agriculture. Assoc. Mem. ASAE.

TABLE 1. MAXIMUM TEMPERATURE DIFFERENTIALS BETWEEN VARIOUS POINTS IN A PROPAGATING BED AND THE SURROUNDING AIR WHEN APPLYING VARIOUS QUANTITIES OF HEAT AND WITH VARIOUS CONDITIONS OF THE BED

(Heating Cables 6 Inches Below the Surface and 8 Inches Apart)

Connected load—watts per square foot of bed, and watts per foot of cable	Condition of bed	Temperature Differential, Degrees F — Air	Sand—midway between cables					Sand—above and below cable				
		2 inches below surface	¼ inch below surface	2 inches below surface	4 inches below surface	6 inches below surface	8 inches below surface	¼ inch below surface	2 inches below surface	4 inches below surface	2 inches below cable	Lead sheath of cable
	Wet-covered	28	38	45	49	53	51	38	46	52	51	66
18.33	Wet-open	2	20	27	33	37	37	20	28	35	37	51
11.0	Dry-covered	27	39	64	84	91	84	40	68	96	84	205
	Dry-open	4	21	49	71	81	75	21	52	82	75	194
	Wet-covered	24	33	38	42	44	44	33	40	43	45	56
15.50	Wet-open	2	17	23	28	31	32	17	24	30	34	43
9.30	Dry-covered	24	35	56	72	79	72	35	59	82	72	172
	Dry-open	3	19	43	62	71	66	19	46	72	66	164
	Wet-covered	21	29	33	36	38	37	29	34	38	37	48
13.05	Wet-open	1	13	18	23	25	25	13	19	24	25	36
7.83	Dry-covered	20	30	48	62	67	62	30	50	70	62	146
	Dry-open	3	17	36	52	60	55	17	38	61	55	140
	Wet-covered	19	25	29	32	33	32	26	30	33	32	41
11.03	Wet-open	1	12	16	20	22	20	12	17	22	22	31
6.62	Dry-covered	18	27	41	52	57	52	27	43	59	52	128
	Dry-open	2	14	31	45	50	47	14	33	52	47	117
	Wet-covered	17	23	25	28	29	28	23	26	29	28	36
9.45	Wet-open	1	10	14	17	19	19	10	15	18	19	28
5.66	Dry-covered	15	22	34	44	49	44	22	36	51	44	109
	Dry-open	1	12	27	39	44	41	13	29	45	41	105
	Wet-covered	14	20	22	24	25	24	20	23	25	24	31
8.24	Wet-open	1	9	12	15	17	16	9	13	16	16	25
4.94	Dry-covered	13	21	32	40	45	40	21	34	46	40	95
	Dry-open	1	11	23	33	39	36	11	25	39	36	91

the bench was used, because it represents about the average minimum temperature in an unheated greenhouse. The data, however, being based upon the temperature differential between the air and the sand, are applicable to any condition.

Table 1 and Figs. 2, 3, 4, and 5 show the maximum temperature differential in the bed between various points and the surrounding air for different conditions and with various connected loads. The temperatures in the air above the sand and in the sand just under the surface were practically the same whether the soil was wet or dry. The temperatures in the sand nearer the heating cable, however, increased more rapidly with the dry than with the wet sand, making a greater difference in temperature between the various points. With wet sand the temperatures directly above and below the heating cable were only slightly higher than midway between the cables. With dry sand there was a greater difference between these points.

In the covered bed the temperatures throughout increased over the uncovered bed. This increase was greatest in the air and surface of the sand and became less nearer the heating cable. The air temperature just above the sand increased only a few degrees when the bed was not covered.

Fig. 6 shows the increase in the temperature of the lead sheath on the heating cable with various connected loads and with different media surrounding it. When the cable was surrounded with air and water, the media were still except for convection currents caused by the heat. When it was covered with sand, the temperature increase was taken as the differential between the temperature of the cable and

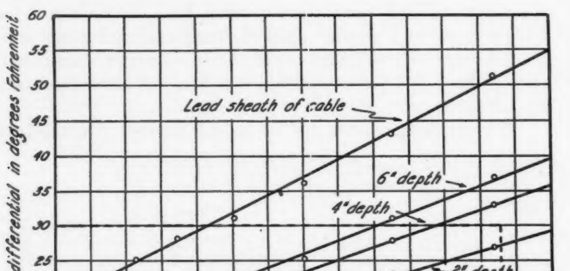


Fig. 2 Temperature differentials between various points in a propagating bed and the surrounding air. Wet sand; bed uncovered. Heating cables 6 inches below surface and 8 inches apart. Temperatures taken midway between cables

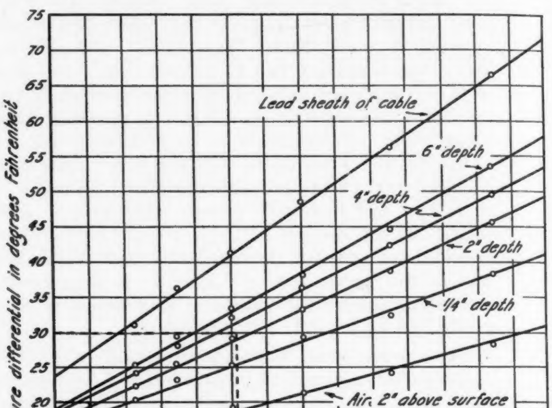


Fig. 3 Temperature differentials between various points in a propagating bed and the surrounding air. Wet sand; bed covered. Heating cables 7 inches below surface and 8 inches apart. Temperatures taken midway between cables

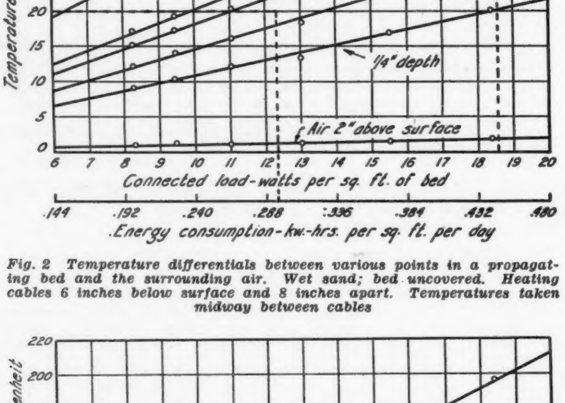


Fig. 4 Temperature differentials between various points in a propagating bed and the surrounding air. Dry sand; bed uncovered. Heating cables 6 inches below surface and 8 inches apart. Temperatures taken midway between cables

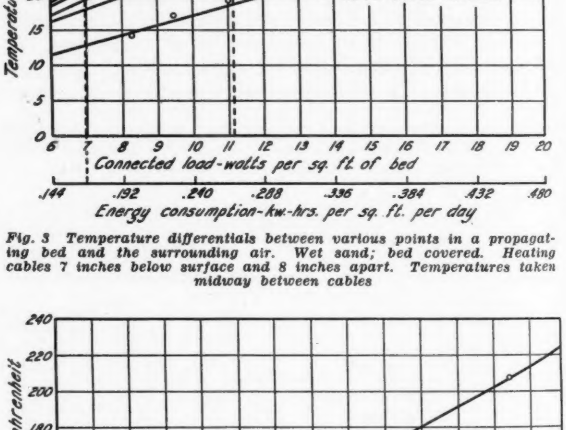


Fig. 5 Temperature differentials between various points in a propagating bed and the surrounding air. Dry sand; bed covered. Heating cables 6 inches below surface and 8 inches apart. Temperatures taken midway between cables

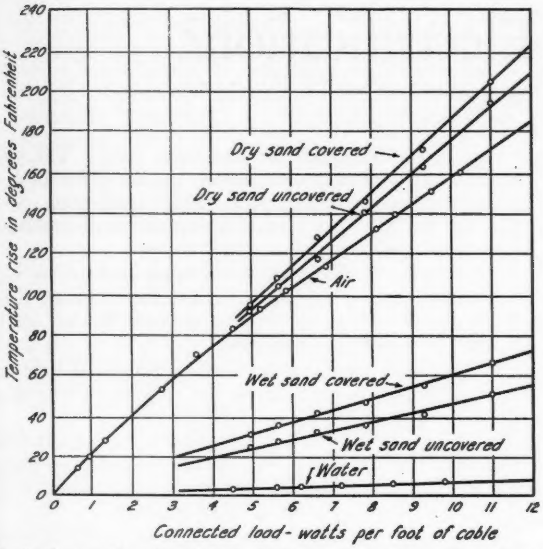


Fig. 6 Temperature rise of lead sheath of cable when surrounded by various media. Temperature rise when buried in sand taken as differential between sheath temperature and air temperature surrounding bed when maximum sand temperature was maintained

that of the air surrounding the bed when the maximum temperature was being maintained in the sand.

USE OF THE CHARTS

Figs. 2 and 3 may be used as a guide in determining the connected load and energy consumption for beds where the plants are placed directly in the sand. As an example, assume a propagating bed for cuttings in which a temperature of 65 degrees is to be maintained at a 3-inch depth with a minimum air temperature of 35 degrees and a mean daily temperature of 45 degrees. To insure sufficient heat the bed must be designed for the greatest temperature differential, which in this case is 30 degrees. In calculating the energy consumption, however, the mean differential is used, in this case 20 degrees. If the bed is not covered, Fig. 2 is used. Going across on the 30 degree temperature differential line to a point midway between the diagonal lines marked 2 in. and 4 in., and then dropping down to the first bottom scale as shown by the dotted line gives about 18.6 watts per square foot as the required connected load. Repeating this process using the 20 degree temperature differential line and dropping down to the second bottom scale gives 0.295 kilowatt-hours per square foot per day as the energy consumption. If the bed is to be covered, Fig. 3 is used. Repeating the same procedure on this chart gives 11.2 watts per square foot as the connected load necessary and 0.168 kilowatt-hours per day per square foot as the energy consumption.

Table 2 compares the actual energy consumption and the theoretical consumption calculated from the charts for two different winters in two beds in practical use. The beds used for rooting cuttings were located in an unheated greenhouse and were not covered. One bed was set to maintain a temperature of 75 to 80 degrees at a 3-inch depth in the sand, and the other 65 to 70 degrees at the same point. The actual energy consumption was lower than the calculated, probably because of two factors: (1) the beds were not kept so wet as the experimental one, and (2) radiation from the sun assisted in the warming. The latter factor was probably also responsible for the larger consumption the second year as compared with the first; there was considerably more rainfall and less sunny weather during that winter.

TABLE 2. COMPARISON OF ENERGY CONSUMPTION ACTUALLY OBTAINED IN PROPAGATING BEDS USED FOR ROOTING CUTTINGS AND THEORETICAL CONSUMPTION CALCULATED FROM FIG. 2

(Area of bed, 32 square feet. Cable, 6 inches below surface and 2 inches above bottom. Connected load, about 14.5 watts per square foot.)

Days heated	Average sand temperature at 3-inch depth, degrees F	Average daily range of air temperature surrounding beds, degrees F	Mean daily temperature differential, degrees F	Actual kilowatt-hours consumed	Kilowatt-hour consumption calculated from Fig. 2
133	77	51 - 65	19.0	1126	1205
133	68	51 - 65	10.0	542	635
182	77	51 - 62	20.5	1716	1780
182	68	51 - 62	11.5	907	990

Figs. 4 and 5 may be used as a guide for determining the connected load in beds where the plants are in pots partially buried in the sand. For this purpose dry sand is better than wet, because there is less heat loss and the temperatures can be maintained with a lower energy consumption.

Fig. 6 can be used as a guide in determining the safe connected load per foot of cable. The manufacturers' recommendation is 6.66 watts per foot. As the chart shows, if the cable is not injured by this connected load when surrounded with air or dry sand, it will not be injured by double that amount when surrounded with wet sand.

John Johnston—The Father of Tile Drainage in America

(Continued from page 352)

was watched, therefore, from the time it came above ground in the fall until the last of it was harvested. The result was a crop of wheat from that ground abundant in quantity and excellent in quality.

"Such, gentlemen, is the result of my labor in draining. I have forty acres of wheat now growing on thoroughly drained land. The improvements in my fields and crops have been great and satisfactory, giving me fine crops of wheat, where formerly it froze out. So well satisfied am I of the advantages derived from the system that I have drained six acres this fall, and shall continue to drain while I have a wet spot on my farm. Your premium list requires that I should give the increased value of the drained land. I feel it difficult to state it in figures. Our farms here are assessed at from $60 to $70 per acre on the tax books. One view of the value, therefore, may be taken; land wholly unproductive, and land worth $60 to $70 per acre. Another view may be taken in the difference in the cost of improvement, say, about $22 or $24 per acre, and its cash value, at this time, of $65 per acre; but on such land as I have, if I get two crops of wheat from my drained land, I am paid by the excess of crop, so as to cover all cost of draining, and sometimes more than paid by one crop, that is, by the excess of crop beyond what it would have been had the land remained undrained.

"The extent of this system of improvement is not, with me, sufficient to give comparative data, or to induce advances on established values of farms originating in drainage. I hope others may have exceeded my sixteen miles of drains, made with tile, then by comparison of cost and results we may better ascertain the increased value of our acres."

In view of the character of the man and the significance of the work which he accomplished it has seemed desirable that there should be set up a suitable permanent monument of commemoration at the Johnston Farm. In pursuance of that idea effort has been put forth to provide for the erecting of a boulder monument with an appropriate tablet. The tablet has been promised, the location designated, a suitable boulder has been found, and, at this writing, all that remains to be done is to secure funds for the moving of the boulder and the setting of the tablet.

It is hoped that this may be speedily accomplished as such a monument is needed to commemorate one of the most important events in the history of American agriculture.

What Is Rural Electrification?[1]

By E. A. White[2]

THE QUESTION — What is rural electrification? — may be simply and directly answered by stating that it is the use of electricity in rural districts or areas. This answer only serves to move the question one step further back to What is "rural"? The Funk and Wagnalls dictionary defines "rural" as "pertaining to the country as distinguished from a city or town."

This definition undoubtedly gives the generally accepted meaning of the word "rural" as it is universally used, but does it apply to the field of rural electrification? With so much being said today about rural electrification, it might be advisable to examine the problem and look at some of the facts to be considered, with a view to finding out, if possible, just what we are talking about. It would appear to be highly desirable if a workable understanding of exactly what is meant by the term "rural electrification" can be developed.

Certainly one of the, if not *the* most widely accepted application of the term "rural", is that established by the U. S. Bureau of the Census with reference to population statistics. This distinction is made in the following language: "Urban areas, as defined by the Census Bureau in recent censuses, have included all cities and other incorporated places having 2500 inhabitants or more. For use in connection with the 1930 census the definition has been slightly modified and extended so as to include townships and other political subdivisions (not incorporated as municipalities, nor containing areas so incorporated) which had a total population of 10,000 or more, and a population density of 1000 or more per square mile." The balance of the population not included in the above definition was classified as rural.

Here a very definite line is drawn. If you live in a town or city of 2500 population or over, you are an urban dweller. Otherwise, with a few exceptions, you are a rural dweller. While there might be questions raised regarding the wisdom of this classification as applied to population statistics, it is entirely satisfactory from my standpoint, and I believe generally accepted as such.

But would it be wise to accept the same line of demarcation when applied to electric service? In other words, is all electric service, except that rendered in towns or cities of 2500 population and over, rural? The word "rural" as applied to electric service has not generally been used in this country to have such a broad application. Some years ago the following general limitations were established as to "rural" customers of electrical energy:

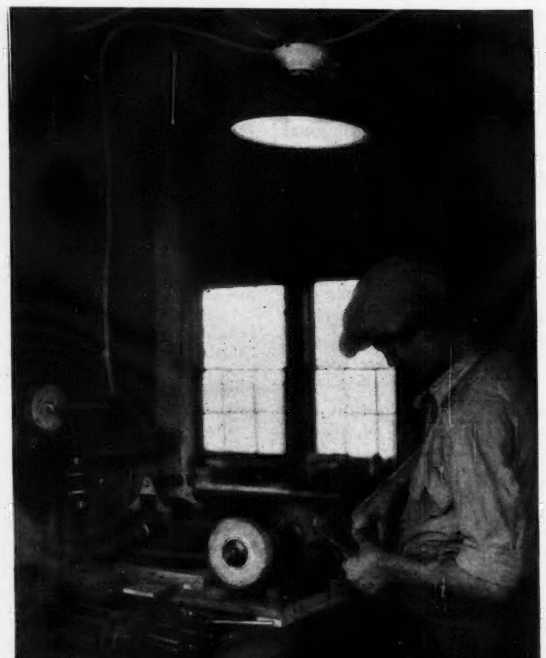
1 *Wisconsin:* "The farmer or other customer of electrical energy who is not located within the corporate limits of any city or village, or in other territory having similar character or density of population."

2 *Illinois:* "Any customer, except industrial light and power customers, located outside the corporate limits of an incorporated municipality."

3 *Indiana:* "One whose premises are without the corporate limits of a municipality, and one requiring an investment per customer's unit demand greater than is ordinarily required for customers within municipalities."

Many other similar definitions might be given, but these typical cases are sufficient to indicate that the definition of "rural" as applied to electric service has not been given as broad a meaning as when used from the standpoint of population statistics.

For the sake of analyzing this problem further as related to electric service, let us establish two rural classifications. In the first instance, let us take the definition of the U. S. Bureau of the Census, which classifies everything in towns or cities of less than 2500 population as rural, which will be designated as "Rural Classification I". In the second case, let us consider everything in incorporated municipalities as urban, and the remainder as rural, which will be designated as "Rural Classification II".



Fortunately, there are statistics compiled by the electrical equipment division of the U. S. Bureau of the Census and the statistical department of the Edison Electric Institute, which clearly indicate the present status of rural electrification for each of the classifications to be used.

Rural Classification I includes everything except towns and cities of 2500 population and over. (See Table 2.)

In Rural Classification II is included unincorporated villages, non-farming country residents, and farmers. Under this definition of "rural" we obtain the data shown in Table 4.

As indicated in Table 4, the electrical energy used in rural areas is estimated, and this estimate does not include that used for highway and street lighting or interurban railway service.

Taking Rural Classification I, we find that we include 43

[1]Paper presented at a session of the Rural Electric Division during the 29th annual meeting of the American Society of Agricultural Engineers at Athens, Georgia, June 17 to 20, 1935.

[2]Director, Committee on the Relation of Electricity to Agriculture. Charter ASAE.

TABLE 1

	Number of homes, April 1, 1930	Homes with electric service, Dec. 31, 1934	Homes without electric service, Dec. 31, 1934
Urban homes	17,372,524	16,170,271	1,202,253
Rural non-farm homes	5,927,502	3,779,526	2,147,976
Rural farm homes	6,604,637	743,954	5,860,683
Total homes	29,904,663	20,693,751	9,210,912

per cent of our population in which there are 5,214,272 electric customers, or approximately one-fifth of the total number of electric customers of all classifications. This rural group of customers uses 7 billion kilowatt-hours of electrical energy annually, or approximately one-tenth of the total amount sold.

Taking Rural Classification II, we find ourselves concerned with 36.4 per cent of our total population in which there are 2,743,954 electric customers—about 9 per cent of the total number of electric customers. This group uses 3,860,000,000 kilowatt-hours annually, or 5.5 per cent of the total sold.

With either classification the remaining rural electric problem is essentially the same, namely, how to reach approximately 5,500,000 farms and serve 2,000,000 non-farm homes together with some customers not included as farms or homes. It should be noted that the number of non-farm customers will not be quite as large in Classification II as in Classification I.

Thus we are right back to the second question asked as the beginning of this paper: What is "rural"? Certainly there can be no question about rural electrification being the use of electricity in rural areas.

In arriving at a generally accepted definition of "rural"

TABLE 3

Population of the United States, 1930	122,775,046
Per cent of population (rural)	43.0
Per cent of population (farm)	24.6
Per cent of incorporated communities (1000-2500) served 1932	100.0
Per cent of incorporated communities (500-1000) served 1932	99.0
Per cent of incorporated communities (0-500) served 1932	85.2
Per cent of incorporated communities (rural) served 1932	92.8
Per cent of homes served (1934)	69.2
Per cent of urban homes served (1934)	93.1
Per cent of rural non-farm homes served (1934)	63.8
Per cent of farm homes served (1934)	11.3
Total Number of Farms in U. S., 1930	6,288,648
Per cent of farms served (Dec. 31, 1934)	11.8
Per cent of rural population with electric service (1932)	37.1
Per cent of farm population with electric service (1934)	10.0
Rural customers, incorporated towns and villages (1932)	2,470,318
Rural customers, unincorporated towns, etc. (1932)	2,000,000
Farm customers (1934)	743,954
Total rural customers	5,214,272
Electrical energy used annually in rural areas (est)	7,000,000,000 kwh
Per cent of electrical energy sold and used in rural areas	10.0
Electrical energy used by agriculture (1934	1,860,000,000 kwh
Per cent of electrical energy sold and used by agriculture	2.63

TABLE 2. AVAILABILITY AND USE OF ELECTRIC SERVICE
(As of December 31, 1932)

Population group	Served exclusively by Private companies	Served exclusively by Municipal enterprises	Served by both private and municipal enterprises	Not served	Total
NUMBER OF COMMUNITIES					
1000-2500	2,547	521	18	0	3,086
500-1000	2,980	319	5	33	3,337
0-500	5,568	399	5	1,038	7,010
Total incorporated	11,095	1,239	28	1,071	13,433
Rural non-farm (est)	24,000				
POPULATION					
1000-2500	3,937,374	851,827	30,229	0	4,819,430
500-1000	2,300,000	231,803	3,992	22,000	2,557,795
0-500	1,482,446	121,501	1,863	200,000	1,805,810
Total incorporated	7,719,820	1,205,131	36,084	222,000	9,183,035
Rural (non-farm)	8,000,000	(small)	0	6,479,675	14,479,675
Rural (farm)	3,000,00	(small)	0	27,157,513	30,157,513
Total	18,719,820	1,205,131	36,084	33,859,188	53,820,223
NUMBER OF CUSTOMERS SERVED					
1000-2500	1,227,070	200,202	8,540		1,435,818
500-1000	600,000	50,000	987		650,987
0-500	360,000	23,000	513		383,513
Total incorporated	2,187,070	273,202	10,040		2,470,318
Rural (non-farm)	2,000,000	(small)	0		2,000,000
Rural (farm)	640,000	(small)	0		640,000
Total	4,827,070				5,110,318

for electrification purposes, we will probably find some differences of opinion based upon personal experience and the angle from which the problem is viewed. If it is looked upon primarily from a rate-making standpoint, we have the definition previously given from the states of Wisconsin, Illinois, and Indiana. It will be readily admitted that for rate-making purposes this definition is logical, but, just as in urban territory, we can have more than one class of rate in rural territory.

There are reasons to believe that from a national viewpoint a more inclusive definition of "rural" is desirable. In this outlook we are concerned with the building of rural America as contrasted to urban America. Therefore, would it not appear logical to accept the well-established definition of "rural" as given by the U. S. Bureau of the Census? If this is done, it will require an orientation of our viewpoint and the more definite focusing of our attention upon the problems of rural development.

TABLE 4

Rural population	44,637,188
Per cent of population (rural)	36.4
Per cent of rural population with electric service (1932)	24.7
Non-farm customers (1932)	2,000,000
Farm customers (1934)	743,954
Total rural customers	2,743,954
Electrical energy used annually in rural areas (est)	3,860,000,000 kwh
Per cent of electrical energy sold and used in rural areas	5.5

Vertical Hitching of Farm Implements[1]

By A. W. Clyde[2]

ONE OF THE MAJOR adjustments which the operator can make to modify the operation of farm implements, particularly tillage tools, is the position and direction of the pulling force. The designer is also concerned in this subject, because by the design he can limit or expand the possibilities of using different hitches. The hitch also has a definite bearing on the stresses in some important parts of the implement. In spite of these facts, the principles of hitches are usually understood only vaguely, and only meager data on them can be found in technical literature.

In order to clarify these principles and to solve certain practical problems the Pennsylvania Agricultural Experiment Station has studied the mechanics of hitching and the forces on implements. The main features of the horizontal adjustment of hitches on plows and tractors have been covered in a previous paper[3]. This paper, therefore, will be limited to the components of forces in the vertical plane of motion. Side components will not be treated, except in so far as they introduce friction or other resistance in the vertical plane of motion.

If, for the present, such special cases as power-take-off torques, air resistance, forces applied to trailing loads, etc., are omitted, the forces on implements can be divided into four fundamental groups, namely, (1) weight, (2) pull applied by power unit, (3) ground resistance or reaction, and (4) inertia.

These forces or resistances must meet the usual requirements for equilibrium; namely, the algebraic sum of the X, Y, and Z components must each equal zero, and the algebraic sum of the moments about any axis must equal zero. Inertia, which enters in when starting, stopping, and striking obstructions, will be left for later consideration. This leaves only three fundamental forces for uniform motion of most implements.

The following symbols will be used (forces listed are the components in a vertical plane parallel to the direction of motion; side components not included):

W, weight of implement which acts at center of gravity

P, pulling force which acts through the point of hitching

P_v, vertical component of P

P_h, horizontal component of P

α, angle of P with horizontal

R_1, soil resistance on the working face and edge of a tool; for example, on the share and moldboard of a plow or the forward side of a cultivator shovel.

R_2, resultant of other soil forces on the tool, such as friction on the bottom or landside of a plow, rolling resistance of wheels, reaction on under side of a dull cutting edge, force for driving a ground drive wheel, etc.

R_3, total soil resistance on tool; it is the resultant of R_1 and R_2.

R_4, part of R_2 applied to front axle.

R_5, part of R_2 applied to rear axle.

All the resistances may be separated into their vertical and horizontal components if desired, but to simplify the drawings the author has not done so.

R_3 is divided into R_1 and R_2 for the following reasons: For any certain tool, depth, and soil condition, R_1 is fixed, and the designer or operator has practically no control over it. In other words, it is a function of tool shape, width, depth, and soil conditions. The other parts of the ground reaction combined into R_2 are, however, largely under control and can be changed by the designer or operator. For example, he may within limits change both the position and direction of the pulling force, the weight, the center of gravity, and the frictional and rolling resistances. It is therefore important to distinguish as far as possible between what the operator can control and what he cannot control. Confusion is likely to result if this distinction is not kept in mind.

Tools without Support Other Than the Pulling Force. Fig. 1 is the simple example of a tool with no supporting wheels or bearing surface. If the tool is symmetrical sideways, the forces shown will all be in the same plane and will be concurrent at O. In this case, there can be no R_2, and R_1 coincides with R_3. For equilibrium P must pass through O, the intersection of W and R_3, and P must balance W and R_3. P_v must equal W plus any downward component of R_1. This means that the weight of such a tool is the main factor which dictates how much upward pull must be applied. If the tool had no weight, P would be equal and opposite to R_1 or R_3.

Tools with Wheels or Other Supports. Figs. 2 and 3 show some conditions in which the tool is supported by wheels, or some other supports. In each case R_1 is the same as in Fig. 1, but W and the position and angle of P have been changed. R_1 and R_2 are first combined into $AB = R_3$ which is produced until it intersects W at O. OC is then laid off equal to AB, or R_3, and the force triangle completed to give P, the pulling force that must be supplied. Conversely, if W and P are known, R_3 can be found; and R_3 can be divided into R_1 and R_2, if either one is known. An important thing to notice is that no one of the forces can be changed as to position, direction, or magnitude without changing at least one other.

When the tool is symmetrical sideways and the side forces are balanced, the forces W, P and R_3 are in the same plane and no couples are present. The limiting value of P_v and α is then reached when R_2 becomes horizontal. In the case of moldboard and disk plows, however, W may not be in the same plane as P and R_1 plus their side components, and a couple is thereby introduced. The total ground reaction including its side component must then include an opposing couple to prevent the tool from tipping over sideways. Only part of W is effective at O, the remainder acting on the other side of the center of gravity.

The practical effect of this is that, when the total forces, including side components, are not coplaner, P_v cannot be as great as it can be when they are coplaner. The location of the center of gravity sideways is therefore of some importance as well as its location lengthwise.

Tests to Determine R_1. In order to get information about R_1, this station has made tests on some tillage tools including plows by two methods. One method was to find

[1]Authorized for publication on July 23, 1935, as Paper No. 697 in the Journal Series of the Pennsylvania Agricultural Experiment Station, and released for first publication in Agricultural Engineering.

[2]Research agricultural engineer, The Pennsylvania State College. Mem. ASAE.

[3]Mechanics of Plow and Tractor Hitches, A. W. Clyde, Agricultural Engineering, 15, pp. 388-390, November 1934.

the value of P at the greatest possible angle α which would keep the tool working at a certain depth without other support. The other method was by the tillage meter which is described later in this paper. Fig. 1 shows the condition found for sharp spring teeth working 3½ inches deep in moderately firm ground. There was practically no bearing surface on the soil, so R_2 must have been almost zero, and the R_3 found must practically coincide with R_1. Fig. 4 shows conditions with a 16-inch plow and rolling coulter in sod about 7 inches deep when it was pulled at nearly the steepest possible angle and at the greatest possible angle to the right. Here again R_2 almost disappeared, and R_1 would nearly coincide with R_3. Walking plows have often been observed with P_v greater than the weight of the plow. A few tests with the tillage meter show that R_1 of a 14-inch plow in sod has a downward component of 100 to 150 pounds. This is more exact than the pulling method and probable values of R_1 and R_2 from the tillage meter are shown in Fig. 4. All this leads to the conclusion that for tools of chisel shape, such as moldboard plows and cultivator teeth, R_1 has some downward slant. Such tools have "suction" when correctly shaped because their shape tends to make them go deeper when pulled ahead. When a tool wears to a rounding edge, an R_2 resistance appears on the under side of the edge which must be overcome or penetration will be lost. Tools of chisel shape are entirely different from those such as disks which depend mainly on weight for penetration.

EFFECTS OF CHANGING FORCES. An implement like Fig. 1 is very sensitive to both position and direction of P. In general, for any combination of W, depth, and soil condition, there is only one possible position and angle of P. No matter whether the beam is attached by a clevis to a tractor drawbar or to horses' traces, the pulling force must be in the proper direction. A walking plow has bearing surface of some length on the bottom. It is therefore like Figs. 2 and 3, except that the "wheelbase" is shorter. This permits slight variation in the height of O and allows considerable choice in the angle α. When front and rear wheels or runners are provided and the tool is constrained by the frame (not floating), there may be a wide variety of positions for O and values of α which will permit good work. The draft, however, may be different in each case. Some combinations will put R_2 far forward, while others will put it to the rear. This is sometimes spoken of as a "transfer of weight" from rear to front, or vice versa. Stability requires only that R_2 be between the reaction points of front and rear wheels; otherwise one end would rise from the ground. R_2 is usually much greater for tractor tools than for horse tools, because of their greater weight and because they are usually pulled with a lower angle α.

If a tool has only one axle without ground drive, O must be so located that R_2 passes slightly behind the axle center as explained for disks and vehicles. The conditions must be the same as those which would remove all load from a second axle, if there were one. The operator then has little choice in location of O, but he can vary the angle α considerably. Ground drive on the wheel requires that R_2 pass farther from the axle so as to give the needed torque to the wheel.

TWO-AXLE VEHICLES. Fig. 5 shows the method of dealing with forces on wagons or any vehicle having front and rear axles. If $R_1 = O$, then $R_2 = R_3$. R_3 can be divided between the front and rear axles by the principle that the ground reaction on an ordinary wheel passes just enough to one side of the axle center to give enough torque for overcoming axle friction. If there were no axle friction the reaction would pass through the axle center. For convenience, it is assumed that the rolling resistance is divided between front and rear in the same proportion as R_3. The exact ratio would depend on the size of wheels and whether the rears tracked with the fronts. For illustration, the rolling resistance is shown large in proportion to W. Effects of changing α and relocating O are the same as in Figs. 2 and 3, namely, (1) increasing α transfers weight from vehicle to power unit, and (2) raising point O transfers loading from rear to front axle, and vice versa.

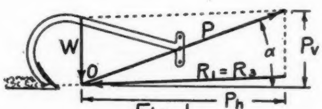


Fig. 1.

Fig. 1 Forces on a simple tillage tool without wheels or other supports

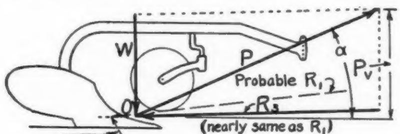


Fig. 4.

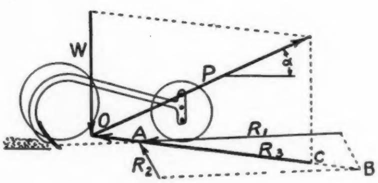


Fig. 2.

Figs. 2 and 3 Two of the many possible force combinations when wheels or other supports are provided. R_1 is the same as in Fig. 1

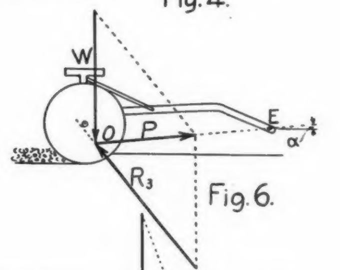


Fig. 4 Forces on a 16-inch plow about 7 inches deep in sod. W was in practically the same plane as the other forces. If W were less, the angle α would have to be reduced

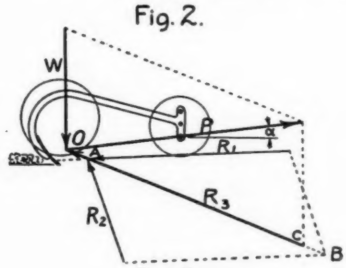


Fig. 3.

Fig. 5 Forces on a wagon or any vehicle with two axles. This could be applied to an implement like Figs. 2 and 3

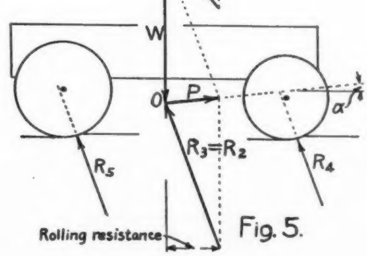
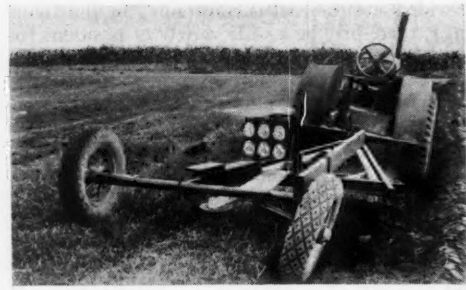
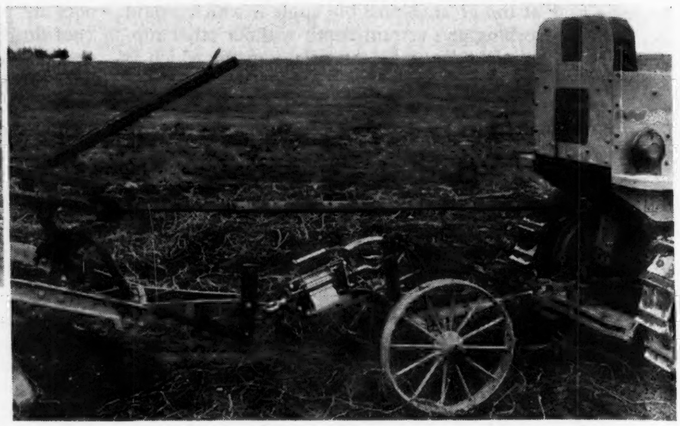


Fig. 6 A disk harrow without tongue truck. Note the difference between it and Figs. 1 or 4





(Above) The tillage meter arranged for plowing. A camera is added close to the gauges for taking a time exposure of them. (Right) Getting the position, direction, and magnitude of the pulling force on a potato digger. When the photo was taken a harvester was being trailed from the digger

Disk Tools Differ from Those of Chisel Shape. As mentioned previously the disk is in an entirely different class than tools of chisel or wedge shape. Primarily its action is that of forcing a cutting edge *down* into the ground, the force for which is furnished mainly by weight. There is no doubt some suctional effect as the soil is lifted at the rear, but it is not nearly enough to give penetration in any but the loosest ground. To appreciate this one needs only to try pulling a disk at a very great upward angle and see how little penetration is secured. Some additional suction is secured for disk plows by tilting the disk, but still great weight is needed.

Fig. 6 shows the forces in the plane of motion for a disk harrow with the forces somewhere near the proportion that often exists. R_3 passes slightly behind the axle center to give torque for overcoming axle friction. It does not seem possible to separate R_3 into two forces as was done for chisel-shaped tools. Only one disk is shown, but the application can be made to the complete tool by considering the one disk at the average fore-and-aft position of the assembly. Important points to notice are the large amount of weight needed as compared with P and the need for increasing W, if it seems desirable to apply P at a greater angle. A certain R_3 must be balanced. Therefore, if either W or P are changed so as to reduce R_3, the penetration will be reduced. Also if a tongue truck is included, the hitch to it should not be such as to transfer much load from the disk axle to the truck axle.

Unjustified claims are sometimes made for unusual penetration because of certain construction between E and the axle. Needless to say penetration is not affected by such details unless they change P, W, or the angle of the blades. Some methods of construction, however, may have advantages in mechanical strength or flexibility.

Forces on Potato Digger Analyzed. Fig. 7 gives an actual analysis of the main forces on a power-take-off potato digger working at moderate depth in moist ground. Because of hilling of the row, the depth of the blade was more than 4 inches, not 2 inches as might be inferred from the drawing. There was a practical reason for doing at least part of this work. When pulling a heavy ground-drive harvester from the rear of the digger, parts of the digger beam were stressed too highly. Tests showed that a P of 1700 pounds or more was sometimes being applied at E with an angle α of about 11 degrees. It was a condition for which no digger is planned. The study helped indicate where and how strengthening should be done to meet the unusual pull.

To secure the data given in Fig. 7 the digger was pulled in the field with a dynamometer hitched at E. Angle α was adjusted until the desired depth was maintained, and P and α were then measured. This includes the power-take-off torque, because the digger has only one axle. The rolling resistance was then found with the blade out of the ground. It would be very nearly the same when digging. The horizontal component of R_1 is 555—100=455 pounds. The vertical component, which includes the weight of some soil on the elevator, was found to be 68 pounds by equating moments about a convenient axis and assuming it applied 60 inches from the axle. The two components make R_1 = 460 pounds located as shown. R_2 was then found as in Figs. 2 and 3. R_2 passes slightly behind the axle center as it must in a one-axle machine without ground drive.

One purpose of this analysis was to determine the bending moment in the beam. The stress can be figured by adding the stress of direct tension to the stress due to the bending moment, for which only P and α are needed. The remainder of the analysis is to show hitching principles. It will be understood that figures given are for moderate conditions only and that for design purposes it would be necessary to have figures for harder digging. Deeper digging would probably increase both P_h and P_v, while dry soil would probably increase P_h mainly.

The study suggests greater possible use of the hitch to help the traction of rubber tires. At present most rubber-tired tractors need extra weight *(Continued on page 364)*

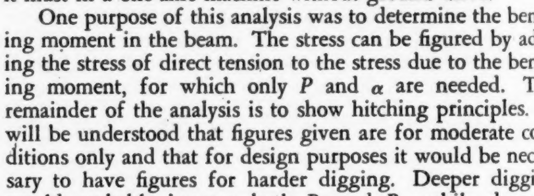


Fig. 7 Analysis of forces on a power-take-off potato digger

Temperature Distribution as a Function of Electric Brooder Performance[1]

By John E. Nicholas[2] and E. W. Callenbach[3]

THE FUNCTION of a machine or mechanism is to carry out a definite event or series of events for which it is designed, or to perform a required service within desired limits. This service may be the transformation of one form of energy into another and its utilization in the most economical way possible. The electric brooder is an apparatus designed to convert electrical energy into heat which is then used to provide comfort for effective brooding of chicks.

The conversion of electrical energy into heat in any electric brooder is an easy matter, but an effective and economic utilization of this heat is a problem of brooder design. Since the advent of electric brooding many types of electric brooders have been constructed. Some of these have undergone changes, while others have been eliminated. This paper is concerned with three available types of electric brooders which have been used in a series of experiments covering the phase of heat distribution.

Brooders Used. The three types of brooders used are illustrated diagrammatically in Fig. 1. They are drawn to the same scale. The two views of each represent the cross section and the bottom view in order to give comparative shapes and to indicate the respective location of the heating elements.

[1]Paper presented at a session of the Rural Electric Division during the 29th annual meeting of the American Society of Agricultural Engineers at Athens, Georgia, June 17 to 20, 1935. Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station, June 11, 1935, as Technical Paper No. 691.

[2]Associate professor of agricultural engineering, The Pennsylvania State College. Mem. ASAE.

[3]Associate professor of poultry husbandry, The Pennsylvania State College.

The small circles on the horizontal line in the cross-section view locate the points at which temperatures were measured. The location of the thermometers supplied with the brooders are not indicated. Their positions, however, were 8, 4, and 21 inches from the periphery of the canopies of brooders Nos. 1, 2, and 3, respectively. The positions of the thermostats, measured from the outer edges, were 7½, 24, and 24 inches, respectively. The curtains used with the brooders are not shown in Fig. 1.

Both brooders Nos. 1 and 2 used a single canvas or felt curtain attached to the periphery of the canopy. Brooder No. 3 is provided with two curtains, one of which is attached to the periphery of the canopy and the other (simple cheesecloth) to that of the inner circle (a 4-inch metal edge) to which the legs are also attached.

The general shape of the brooders is conical. Nos. 1 and 3 are circular. No. 2 is a square cone. Brooder No. 1 is of double cone construction with approximately 1 inch of air space between the cones. The inner cone has its crown inverted so that its apex is 6½ inches off the floor when the brooder is in operating position.

Brooder No. 1 is heated by a single-coil element which is enclosed in a series of short porcelain tubes which are 6½ inches above the floor when the brooder is resting on the legs supplied by the manufacturer. The element is located just within the edge of the inverted cone (Fig. 1).

There are two heating elements in brooder No. 2. These are located between two black iron sheets. The elements constitute two separate circuits, so that either or both can be used. The cross-hatched portion in Fig. 1 indicates the size and shape of the sheets which contain the heating elements. In the several series of tests reported here only one element was used, because that was the manner in which

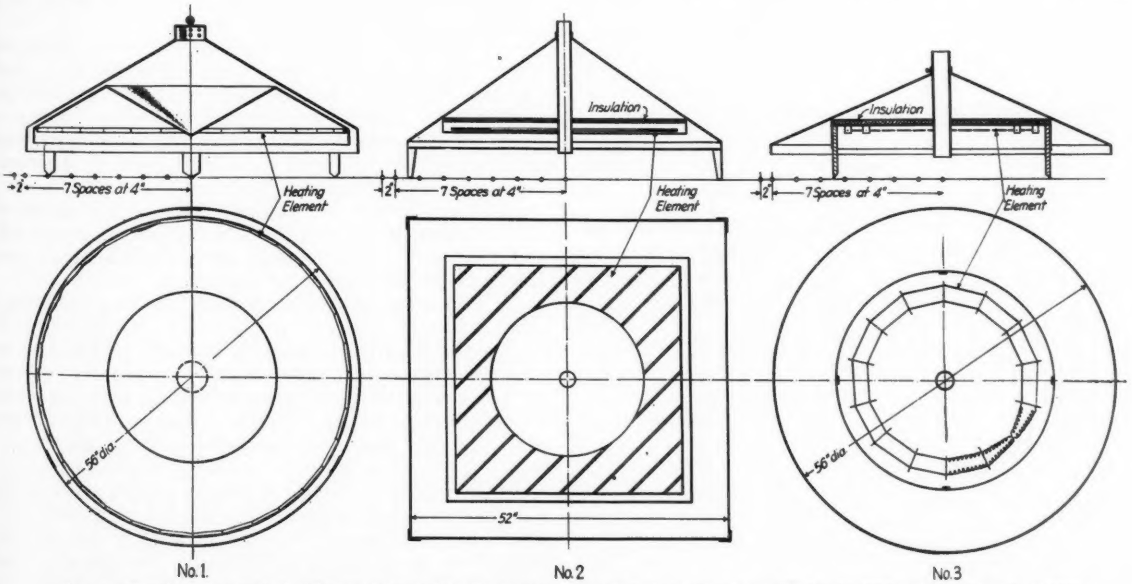


Fig. 1 The three types of electric brooders used in the series of experiments at the Pennsylvania Agricultural Experiment Station

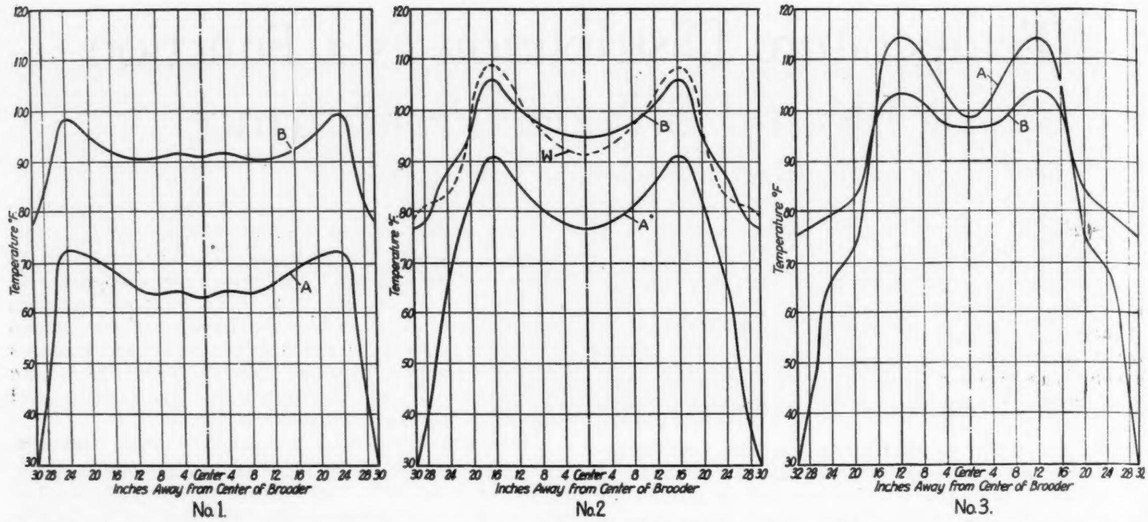


Fig. 2 Temperature distribution under brooders when empty, no curtains used and tested on smooth cement floors. Curve A, brooders operating in a 30-degree room. Curve B, brooders operating in a 75 to 77-degree room. Curve W, brooder No. 2 operated with 1000-watt element in a 75 to 77-degree room, instead of with 500 watts as in the regular tests

the brooder was assembled at the factory and because the wattage with this assembly was approximately the same as for brooders Nos. 1 and 3. The heating assembly is 8 inches above the floor when the brooder rests on the floor.

Brooder No. 3 has open-coil elements with two circuits in parallel which are spaced by porcelain knobs as illustrated in Fig. 1. In this brooder the elements are 8½ inches above the floor.

Brooder No. 1 is not insulated. It is ventilated through the annular air space between the cones and the adjustable vent holes in the chimney as indicated in Fig. 1. Brooders Nos. 2 and 3 are both insulated. The former is ventilated through a chimney adjustable for height but not for size of ventilator opening. The latter uses a chimney tube which is adjustable for height and number of vent holes which are arranged on the sides of the tube. The data on size, weight, rating and capacity of each brooder are compiled in Table 1.

TABLE 1. DATA FOR PHYSICAL CHARACTERS OF BROODERS

Brooder No.	Size, inches	Weight, lb	Rating on 110-220 volts	Wattage when tested	Available space under canopy, sq in
1	56 (dia.)	53	550 watts	525	2463
2	52 (sq.)	78	(not indicated)	510	2704
3	56 (dia.)	46	440 watts	505	2463

The primary function of a brooder is to provide heat at proper temperatures. The purpose of this investigation was to determine the heat distribution as measured by temperatures under the three types of brooders studied.

METHOD OF INVESTIGATION. To obtain accurate temperatures at various points under the brooder when in actual operation nine thermocouples made with No. 30 copper-constantan wires were used. These were spaced in order to give seven 4-inch intervals and one 2-inch interval as shown in Fig. 1. The couples were mounted on a 2½-inch wooden strip which was long enough to have the ends project beyond the outer edges of the brooders. The first thermocouple was located at a point immediately under the center of the brooder. With brooders Nos. 1 and 3 this placed the eighth couple at the edge of the brooder and the ninth 2 inches beyond, in the outside air. In brooder No. 2, because of smaller diameter both couples eight and nine were outside the brooder.

The first series of tests were conducted in the experimental laboratory of the Department of Agricultural Engineering. The curtains were not used. The laboratory room temperature varied from 75 to 77 degrees (Fahrenheit) during the three days. These and all succeeding room temperatures were measured 2½ inches above the floor. To avoid possible drafts, all doors were closed and each brooder was put into operation under thermostat control. The first readings were taken after two hours of operation.

A two-hour period of operation before taking any readings was considered a sufficient interval to establish thermal equilibrium in a 75 to 77-degree room. Repeated readings were taken at the end of 4, 6, and 8 hours. Since no variation appeared between cycles at various intervals, the temperatures recorded at the time the current shut "off" were considered representative for each brooder; these are shown as curves B in Fig. 2.

An identical series of tests was made in a 30-degree room. To obtain a uniformly cold temperature, a small room in the apple storage plant of the Department of Horticulture was used. The brooders were set up one at a time, put into operation during the night, and readings were secured the following day. The results of this series of tests are shown by curves A in Fig. 2.

The above work was completed during the month of July 1934, and provided laboratory data. In order to verify and check the information thus secured, similar tests were planned with the following changes:

1 The tests to be under actual brooding conditions, using chicks.

2 The tests to be made in the cold season with as nearly a 30-degree temperature as it is possible to obtain.

For these tests, 320 Single Comb White Leghorn chicks were hatched on January 28, 1935. A standard 10-by-12-foot colony brooder house was prepared with all the experimental apparatus in place. A heavy bed of planer shavings was used for litter. A 2-by-2 mesh hardware cloth guard was used to tightly encircle each brooder as it was used. The guard was covered with burlap sacks to prevent the chicks from seeing outside the brooder. This procedure was very helpful in keeping them quietly under the canopy.

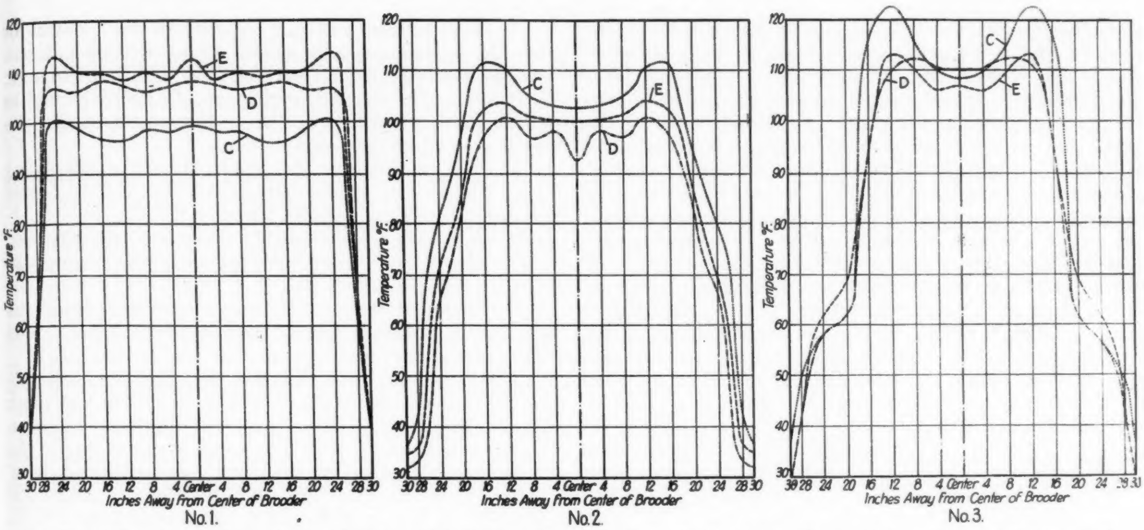


Fig. 3 Temperature distribution under brooders in actual use in a 10-by-12-foot brooder house operating in winter with the following conditions: C, no chicks; D, 320 chicks under canopy and heat just on; E, 320 chicks under canopy and heat just off

January 29, 1935, was very favorable for the experiment. An overcast sky and a 5-mile wind maintained an outside temperature of 29 degrees at 9:00 a.m., 28 degrees at 2:20 p.m., 27 degrees at 3:30 p.m., and 24 degrees at 5:30 p.m., when the experiment ended. By regulating the ventilation of the brooder house the indoor temperature was kept constant at approximately 31 degrees.

Previous to placing each brooder in the colony house, the brooder thermostat was readjusted to provide, so far as possible, a temperature suitable for chicks. Because of a lack of insulation in brooder No. 1 and faulty operation of the thermostat in brooder No. 2, it was not possible to bring the former, when empty, to the temperature desired, or to hold the latter at this temperature after the chicks had been placed under it. Before placing chicks under each brooder, it was given sufficient time to come up to temperature, and a temperature distribution record was made at the end of the heating cycle. Curves C in Fig. 3 represent the temperature distributions. Ventilation of each brooder was kept at the minimum possible within the limits of the construction of the brooder.

Three hundred and twenty selected Single Comb White Leghorn chicks were quickly placed under the brooder canopy and temperature readings begun immediately. The rated chick capacities of the several brooders were not considered in determining the number of chicks to be placed under each brooder. The arbitrary number of 320 chicks was chosen because it represents the greatest number of chicks per brooder pen group as recommended by the Department of Poultry Husbandry.

Temperature distribution readings were made and recorded every 5 minutes. After the chicks became distributed under the canopy and had quieted down, readings were made at the beginning and end of the heating cycle. These are referred to as the "on" and "off" periods. Curves D and E in Fig. 3 represent these "on" and "off" temperature distributions under actual chick brooding conditions.

Discussion of Results. Curves B, Fig. 2, show that brooder No. 1 generated a much more uniform distribution of temperature than brooders Nos. 2 and 3. The maximum temperature variations within the directly heated areas of the brooder canopies were 8.8, 11.0, and 5.2 degrees, respectively, for brooders Nos. 1, 2, and 3. However, the maximum temperature variations for the entire areas under the brooder canopies were 15.5, 18.2, and 22.2 degrees. Using 90 degrees as a satisfactory minimum empty brooder temperature, 87.5 per cent of the floor space of brooder No. 1 was available for chicks, whereas brooders Nos. 2 and 3 provided 75.0 and 57.7 per cent, respectively. Using the areas included in these percentages, the maximum variations in temperature within the zones for the brooders in the order indicated above were identical with the variations for the areas within the directly heated areas. When brooder No. 2 was heated with the 1,000-watt element, even less uniformity of temperature distribution (curve W in Fig. 2) was obtained than with the element of lower wattage.

The A curves in Fig. 2 show the same characteristics as the B curves for all brooders, except that the temperature differences between the inner and outer portions of the areas under the canopies were 29.1, 25.6, and 72.8 degrees. The curves show that the most severe variations held good for relatively small areas, particularly in brooder No. 1. It should be noted, however, that the maximum temperature it was possible to obtain with continuous operation of this brooder was 72.4 degrees. This, again, indicates the necessity for proper prevention of heat loss by radiation through the canopy of this brooder. In the cold storage test, brooder No. 3 was operated with and without the inner curtain, without any significant effect; that is, the temperature differences with or without the inner curtain were the same.

Fig. 3 shows the temperature distribution results for all brooders when operated under commercial conditions in the unheated colony house. As in the two previous tests, brooder No. 1 showed by far the most even distribution of temperature under the canopy and also the greatest percentage of usable brooding area after the chicks were placed under the brooder. However, because of the heat loss caused by an entire absence of insulation, it was impossible to bring the brooder temperature of this model, when empty, up to the desired point. Furthermore, it was necessary to increase the ventilation of the brooder house while this brooder was being tested because of the additional heat radiated into the room from the brooder. The influence of the heat generated by chicks under an electric brooder is demonstrated excellently by a comparison of curve C with curves D and E of brooder No. 1 in Fig. 3.

Curves D and E for brooders Nos. 2 and 3 in Fig. 3

show that the presence of chicks under the canopies tended to flatten the curves, when compared to curves C. In other words, the presence of a well-distributed group of chicks under an electric brooder tends to bring about a more even temperature distribution. This is particularly true for the peaks. However, neither of brooders Nos. 2 and 3 supplied as great a percentage of usable brooding area under the canopy as brooder No. 1. The relative percentages of usable brooding area under the canopies of the three brooders were 86.6, 56.8, and 50.6 per cent, respectively, considering 100 degrees (using curve E) as the lowest comfortable brooding temperature. The variations in temperature in these areas were 13.4, 4.0, and 13.4 degrees. Curve D of brooder No. 2 in Fig. 3 shows lower temperatures than curves C and E. This is explained by the circumstance that the thermostat of brooder refused to function properly and manual manipulation of heat generation was resorted to. Also it was impossible to control heat loss of this brooder through ventilation, since the ventilating flue was of open-chimney construction, therefore, without draft regulation.

The findings demonstrate several requirements of electric brooder construction.

1 The location and heat capacity of the element or elements are of great importance. There must be sufficient wattage available for all extremes of room temperature. Furthermore, the element or elements should be located in such a position that heat can be made available to all parts of the area under the brooder canopy.

2 It is essential that the generated heat be distributed under the brooder canopy in such a manner as to supply the maximum "chick comfort" area.

3 A reliable and reasonably sensitive thermostat must be provided in order that proper operating temperatures can be secured and held.

4 Proper control of ventilation and suitable insulation in order to prevent waste of available heat are necessary for economical operation.

The ability of electric brooder manufacturers to supply brooding equipment which fulfills satisfactorily the above requirements, plus proper management by the poultryman to prevent mechanical difficulties from overcrowding in the limited brooding area available, will go far toward determining the success of electric brooders in the commerical production of laying pullets in the temperate zone.

Vertical Hitching of Farm Implements

(Continued from page 360)

on the rear axle, particularly when plowing. Tractor plows are heavy and could be pulled at a much greater upward angle than is customary. A shorter, steeper hitch to the tractor would transfer more load from the plow axles to the tractor, and a higher hitch on the tractor would transfer more load from its front axle to the rear. Advantage might be taken of this to reduce the amount of weight added to the tractor. Probably also, the tractor rear wheels could carry weight with less rolling resistance, than the plow wheels. As opposed to such possible advantage, one would have to consider the disadvantage of a short hitch where the power unit is wide as compared to the plow. There would seem to be little possibility of using this principle with disks because it would reduce the penetration.

Tillage Meter for Studying Soil Resistances. In order to study the action of soil forces on tools, this station with the advice of Professor K. J. DeJuhasz, of the Pennsylvania Engineering Experiment Station, has just built an apparatus which has been named the "tillage meter." It consists of a main frame mounted on rubber tires and a subframe to which the tool is attached. The subframe is connected to the main frame by six hydraulic dynamometers. Three measure vertical forces, two measure fore-and-aft forces, and one measures the side force. These give data to locate the soil resistance in three planes as to position, direction, and magnitude. When a plow is used, the landside is omitted and the gunnel of the share is relieved so that there is practically no bearing surface against the furrow wall. This is to insure getting practically all of the side force on the dynamometer. At present six indicating gauges are provided, and a camera is used to get simultaneous readings of all six. It is hoped to add a recording mechanism later. The main objective is to secure information on soil resistances to use for

1 Designing tools for mechanical strength
2 Deciding best location for pulling forces
3 Studying effects of various shapes of tools.

The details of the tillage meter and the results secured with it will be the subject of a later publication.

SUMMARY

1 The position and direction of the pulling force is one of the important ways by which the designer or operator can influence the performance or draft of a farm implement.

2 The forces on implements conform to the common laws of mechanics for equilibrium of forces in space. If certain special cases are omitted and uniform motion is considered, the forces may be divided into only three groups: the weight, W; the pulling force, P, and the resultant soil resistance, R_3. (Special cases can be handled by including the additional forces or torques).

3 If possible, R_3 should be separated into its controllable and uncontrollable parts.

4 The range within which the position and direction of P can be altered is governed mainly by whether or not the tool has wheels or supports on the soil, the positioning of such supports, the weight of the tool, and the position of the center of gravity. The effect of moving W backward or forward will be obvious. Raising point O moves R_2 (or R_3) forward and transfers load from rear to front, and vice versa. Increasing angle α transfers load from implement to power unit. P_h is usually reduced by increasing α, because the backward component of R_2 is thereby reduced. Whether or not this saving is all realized by the power unit depends on its ability to carry more downward load.

5 Advantage may be taken of the foregoing to reduce the slippage of tractor drivewheels, particularly with rubber tires in plowing.

6 Tools of chisel or wedge shape are much different than disks. The former, when properly shaped, usually need to be held from penetrating too deeply, while the latter must be forced into the ground (usually by weight). The soil reaction on the working face and edge of sharp chisel-shaped tools apparently always has some downward component when the ground is moist. The effect of dry soil in this connection has not yet been studied.

7 The principles explained and the applications given to different types of implements can be used for more intelligent design and operation. Even though some approximations may have to be made, the result should be better than can be expected without this analysis.

Light Traps for Codling Moth Control

By G. E. Marshall[1] and T. E. Hienton[2]

THE USE OF LIGHT to attract noxious insects, so that they could be destroyed, was one of the earliest control recommendations, although the practice never received the approval of entomologists, since studies showed that light sources used were impractical from a control standpoint, probably because few of the attracted individuals were females. With the fundamental studies on the reaction of insects to light of different wave lengths by Lutz, Collins and others, the subject has been revived, and the results of studies the past few years, especially those of Collins and Herms, have indicated possibilities in the use of certain lamps under certain conditions as an aid in the control of specific insects. To determine the possibilities and attractiveness of different light rays, the Purdue University Agricultural Experiment Station inaugurated a series of fundamental studies in 1933 which gave such significant results that the studies have been continued each year since that time. For the information of others interested in the problem of insect control by use of light as an attracting agency, the results of the first two years' study are here briefly given as a preliminary or progress report.

It is apparent that the solution of this problem is through the study of the individual species of insects and the kind of lamps most attractive to each as shown by the work of Herms (10)* with dark blue lamps on fig and grape insects. Present knowledge indicates it is not practical to attempt to repel insects by increasing the intensity of light, since Headlee (7) found in his work with codling moth that results obtained by an illumination of 10 foot-candles were of slight benefit, about 30 foot-candles being necessary to affect the activity of that insect. Herms (8) found that in most highly illuminated areas in apple orchards (between 11 and 112 foot-candles) the intensity of artificial light was not sufficiently high to wholly prevent codling moths from entering this area and depositing eggs.

Work at the Purdue University Agricultural Experiment Station in 1928 and 1929 showed very definitely that gasoline-flame lamps offered no considerable attraction to the female codling moths. A pressure gasoline lantern with mantles, which produced a brilliant white light, proved to be so attractive to the codling moth adults in the packing house that this lantern was used at times for collecting the moths in such buildings, thus preventing them from escaping to the orchard.

In 1931 and 1932 the entomologist engaged on this project made a study of colors as a factor which might influence the attractiveness of baits to codling moths. Records obtained in 1932 from 10 observations of 1080 moths, the equivalent of one moth alighting 10,800 times, showed that 928 alighted on blue, 795 on green, 783 on white, 682 on black, 688 on yellow, and 533 on red. Essentially these same results were obtained in 1931, when white was found to be 16 per cent more attractive than black as a resting place, and also in the field bait trap tests where white traps caught 32 per cent more moths than black ones. Blue caught 25.54 per cent more than black. A summary of both field and laboratory tests reveals that blue and white were most attractive with red and black usually less than yellow and green.

In 1933 a definite project was inaugurated to determine electric lamps most attractive to the codling moth. During that season, 11,201 moths were trapped using the electrocuting type of trap (Fig. 2), while 2630 moths were taken in 25 bait traps filled with molasses and citronellal or citral. This amounts to 1.02 moths per trap per day which is considered a good catch for baits while the electric traps averaged 17.3 moths per day. Of the total caught in bait traps, 2020, or 76.8 per cent, were females. The light traps caught only 43.1 per cent females, the total catch being 5160 males, 3919 females, and 2122 unidentified as to sex.

Lamps employed in 1933 were Mazda C, Mazda CX, and standard G-1. The first is the common gas-filled lamp used for ordinary lighting; the second essentially the same, except for a special ultraviolet transmitting bulb, while the third is a low-pressure, mercury-arc lamp which radiates ultraviolet light. Lamps of the latter two types were employed both in inside frosted and clear bulbs, while the Mazda C was used only with inside frosted bulb. Energy output of these lamps at various wave lengths is shown in Table 1. Reference to this table and the complete ether spectrum depicted in Fig. 1 will show that the standard G-1 radiates more energy in the ultraviolet than either of the other lamps.

The installation in 1933 consisted of eight of the best locations that could be found in the orchard, using one

[1]Associate in entomology, Purdue University Agricultural Experiment Station.

[2]Associate in agricultural engineering, Purdue University Agricultural Experiment Station. Mem. ASAE.

*Figures in parenthesis refer to bibliography following this paper.

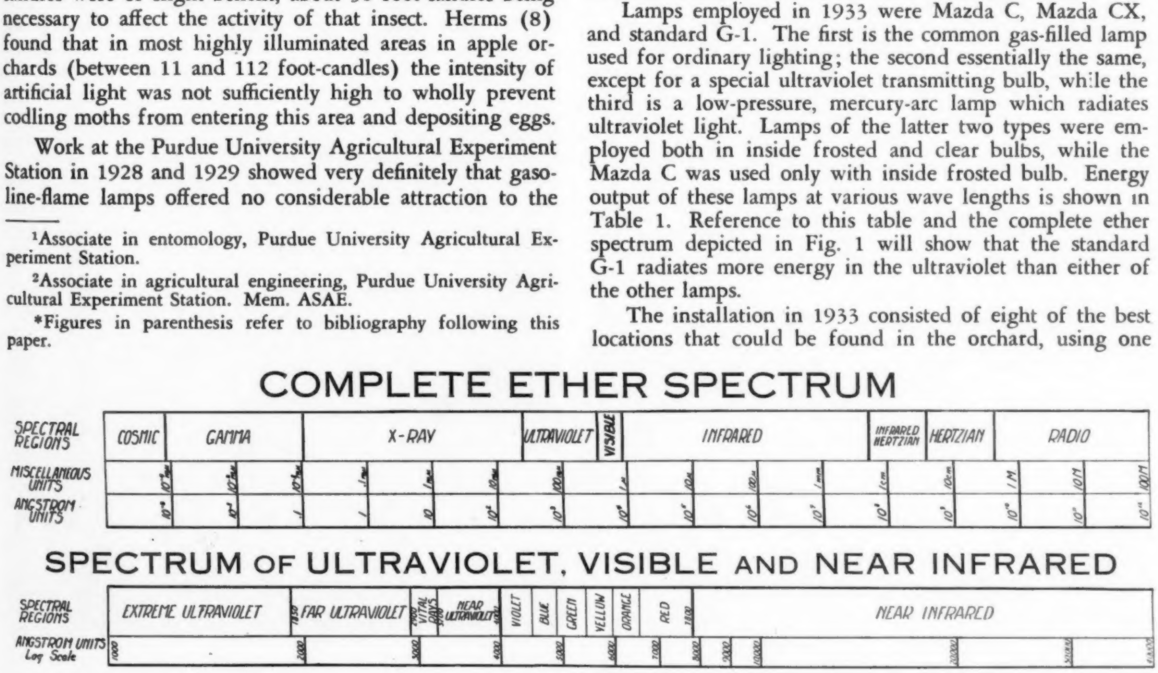


Fig. 1 The complete ether spectrum

TABLE 1. MICROWATTS PER CM² per 500 ANGSTROM UNITS AT ONE METER DISTANCE*

500 A band centered at	7250	6750	6250	5750	5250	4750	4250	3750	3250	2750
60-watt Mazda C	8.3	7.2	5.8	4.35	2.96	1.74	0.80	0.28	0.05	
60-watt Mazda CX	8.8	7.7	6.3	4.80	3.30	1.95	0.98	0.37	0.10	0.006
Standard G-1	0	0	0	1.02	2.34	0	4.50	1.26	1.13	0.140
Special G-1, limeglass	0	0	0	1.00	2.30	0	4.50	1.26	0.70	0.020
Special G-1, purple corex	0	0	0	0	0	0	1.26	1.23	1.20	0.170
Mercury vapor tube				0.099	0.360	0	0.792	0.215	0.151	0.001

*Figures furnished by Lamp Dept., General Electric Co., Cleveland, Ohio.

lamp per tree (Fig. 3). The lamps were changed periodically during the 78 days of operation. Table 2 gives the per trap per day catches for the five lamps employed with per cent of females for duplicate tests.

It was found that the position in the tree was more important than the light source used for those tested in 1933. For example, at one position 2525 moths were captured during the entire period, while at another, during the same time, less than 900 moths were captured, using the same kind of lamp in each position. Some preference was indicated for lamps with clear bulbs to the inside frosted ones on both CX and G-1 lamps.

TABLE 2. CODLING MOTH CATCHES PER TRAP PER DAY, 1933

Lamp	Per trap per day, number	Female moths per cent	
60-watt Mazda C, inside frosted	11.07	40.0	45.5
60-watt Mazda CX, inside frosted	10.61	35.2	39.5
60-watt Mazda CX, clear	15.82	49.4	51.0
30-watt G-1, inside frosted	28.76	44.7	38.5
30-watt G-1, clear	25.10	43.2	47.4

The results of these experiments to date indicate that the best position for the trap is in a tree which carries a full load of fruit, has a fairly broad top and is located higher on a ridge or is taller than the others. This agrees with the work done by Peterson and Haeussler (2) on the oriental fruit moth. The trap should be at least a foot below the topmost foliage. How far down into the tree the trap can be put before the catch will be reduced is not known, but is apparently dependent to a large extent on the density of the foliage and the limb obstructions. The trap should be as near the center of the tree as is possible. The reason moths are most active from 20 min before until 20 min after sunset has been explained by Collins in results of recent studies at the Geneva (New York) station as given at the December 1934 meeting of the American Association of Economic Entomologists. In addition Borden (1) has studied the activity of this insect at the sundown period. Although all but a small part of the catch was made between dusk and 10:30 p.m., it was found that flights did occasionally occur at dawn and that the best commercial control could be obtained by operating the lights all night (3).

In consequence of the 1933 results, the 1934 work was enlarged to include laboratory as well as field tests. Each light source was tested in competition with others first in the laboratory and then in the orchard. Research work was concentrated on attempts to answer the following problems in the use of electric traps:

1 To what extent and distance can moths be drawn out of the orchard away from apple trees?

2 Is it light alone that attracts moths to the traps?

3 Of the lamps tested, which is the most attractive?

4 Could the most attractive light source be improved upon by reflectors?

5 Do codling moths in the laboratory react the same to lights as they do in the field?

Lamps included in the 1934 work besides those used in 1933 were the 60-watt Mazda C, clear; 100-watt Mazda C, clear; 100-watt Mazda C coiled-coil filament, clear; 200-watt Mazda C; 200-watt daylight; photo-flood, a lamp of short life but of high light output; special G-1's, with clear lime-glass bulbs; special G-1 lamps, with purple corex bulbs; 15-watt mercury-vapor tubes. Energy output of the special G-1 lamps and mercury-vapor tube in the visible and part of the ultraviolet regions of the spectrum are shown in Table 1.

The laboratory work was carried on in a three-story frame packing house 72 by 72 ft from which at least 265,000 codling moths emerged during the season. This emergence was from used baskets stacked around the walls, from cracks and crevices in the floors and side walls of the building, and from the grading and packing machinery. Four different lamps, hung in a square near the center of the room, were used in competition with each other. Use of this building eliminated the necessity of handling the moths before using them in the tests and the large space offered by it tended toward normal activity. The entire building was inspected daily and all live moths found at the windows or elsewhere were killed, so that each day a new lot was used in the tests.

All the observations in the packing house studies were made between 7:00 and 12:00 p.m. unless otherwise stated. A period of 30 min was the longest necessary for a single observation, and often one of only two minutes was sufficient when the daily emergence was heavy. Lamps in competition with each other were switched on simultaneously and after several observations they were changed to eliminate any error of favored position. Between June 2 and 12,

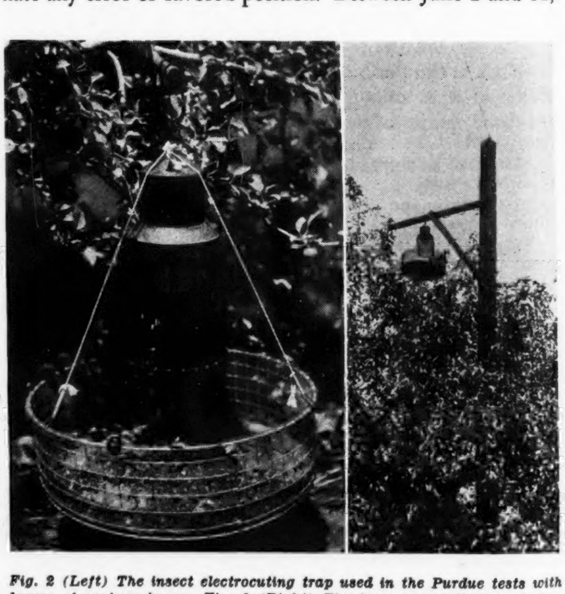


Fig. 2 (Left) The insect electrocuting trap used in the Purdue tests with lamps of various types. Fig. 3 (Right) The type of installation used in the 1933 studies with one light trap per tree

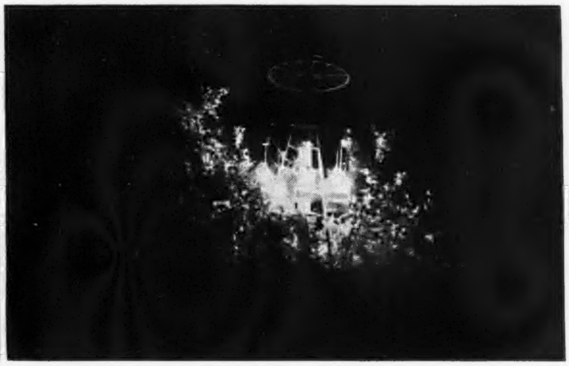


Fig. 4 (Left) Six electrocuting traps suspended from a wheel in the top of a tree, as used in the 1934 experiments. Fig. 5 (Right) The second wheel used in the 1934 outdoor tests, in operation after dark

moths emerged at the rate of more than 12,000 per day with the peak of emergence, on June 7, of 15,579.

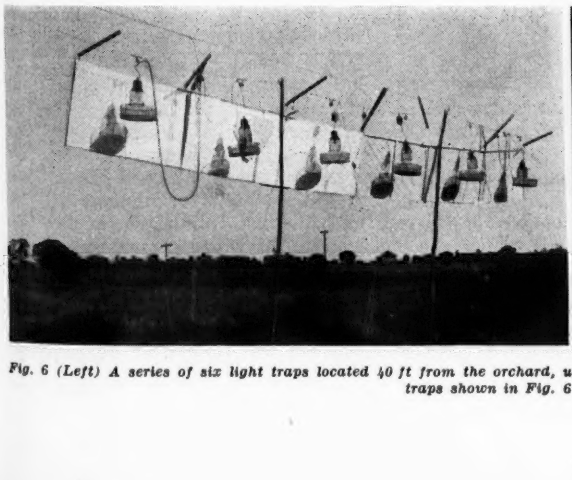
Results of the laboratory tests paralleled those in the field, except in a few instances, and for that reason they will not be listed except where they differed from the field data. In the laboratory, if only one light source is used, practically all of the moths will be attracted, one lamp being as effective as another. This is not the case in the field where the ultraviolet sources attract more moths than others so far tested.

A photo-flood lamp (a short-lived lamp of high light output) proved to be the most attractive lamp tested. A lamp with a coiled-coil filament proved to be no more attractive than the same lamp with the regular filament. Lamps flashed on and off at intervals of three seconds or longer were far less attractive than those in constant use. Contrary to the work by Peterson (2) daylight lamps were less attractive than the regular Mazda C lamps of the same wattage.

On the second floor of this packing house a trap with a 60-watt Mazda C lamp was operated from early evening until just after dawn. All the windows in the building were then visited and the moths that had not been attracted to the trap killed and counted. All but 2.48 per cent had been destroyed in the trap. On the first floor of the building a trap with a 100-watt Mazda C lamp was operated for 24 hr a day, and such openings as windows and doors darkened with the aid of burlap sacks, apple boxes, etc. Any other large opening such as knot holes were closed, but it was impossible to close hundreds of small cracks where the siding did not fit together tightly. Counts showed that all but 1.32 per cent of the moths were trapped by this lamp. In view of this evidence, the Purdue University Agricultural Experiment Station recommends the use of an electric trap with a clear lamp of not less than 100 watts on each floor of packing houses, in addition to the screening of such buildings to prevent escape of moths.

The 1934 field tests were planned to be as comprehensive as possible to determine whether lamps radiating ultraviolet energy were more attractive than lamps of higher light output in the region visible to humans. Two installations of six electrocuting traps, each with a different lamp, were suspended from a wheel which revolved in a horizontal position near the top of a tree, as seen in Figs. 4 and 5. Two additional installations of six traps each, one of which is shown in Figs. 6 and 7, were installed at the edge of the orchard in a line parallel to it.

Using one tree as the unit instead of several, it was found much easier to arrange the traps than with a trap in each tree of a large block. In addition, it required no time to go from one tree to another. A stub telephone pole was set up with the top end near the center of the top of the tree. The pole was sawed off level on the top and into it was driven a piece of pipe which made the axle for a wheel six feet in diameter. The six light traps were hung from the rim of the wheel at equidistant intervals so that they could be raised or lowered at will. Beneath each trap was hung a tray 6¼ in deep and 20 in in diameter to catch the insects killed. The trays were made with metal bottoms and reinforced screen wire sides. Soon after the experiment was started, it was found that certain birds visited the traps early in the morning and robbed them of



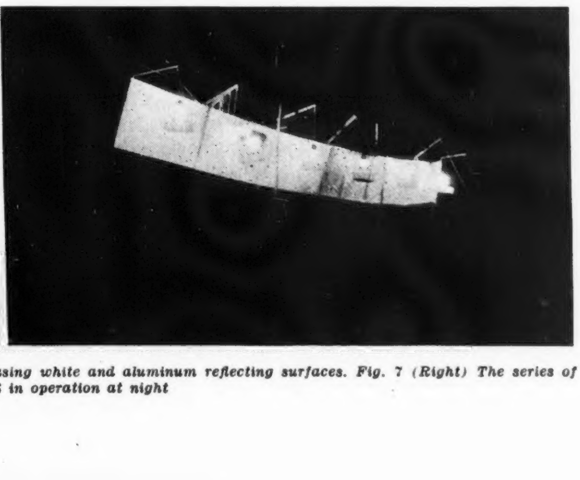


Fig. 6 (Left) A series of six light traps located 40 ft from the orchard, using white and aluminum reflecting surfaces. Fig. 7 (Right) The series of traps shown in Fig. 6 in operation at night

captured insects. To remedy this situation, trays of 1-in mesh wire were fitted in traps to rest 2½ in below the top.

During the tests the wheel was rotated one-sixth of the circumference each night to give each trap an equal chance in any favored location that might exist on the circumference of the wheel. Two trees were used with this six-trap arrangement. After six light sources had been used long enough to gather the information desired, six more were installed. The lamps were in operation from dusk until dawn. The per trap per day catch from May 11 until July 21 is shown in Table 3.

TABLE 3. COMPARISON OF CLEAR AND INSIDE-FROSTED LAMPS, MAY 11 TO JULY 21, 1934

Lamp	60-watt Mazda C		60-watt CX		30-watt G-1	
	Frosted	Clear	Frosted	Clear	Frosted	Clear
Moths per day	2.86	2.70	3.58	4.49	5.81	11.47

The total catch per day for the entire season for the two units was 61.82 moths, or 30.91 moths per tree. During the period of May 11 to July 21 the total catch for the two trees was 4266 moths, or 2133 per tree. Between July 21 and September 6, the end of the season, the per tree catch was about 40 moths per night or during the period, 1880. For the entire season the per tree catch was 4013.

The three G-1 lamps and mercury-vapor tube were tested between July 21 and September 6, and the per trap per night catch is shown in Table 4 and Fig. 8.

TABLE 4. COMPARISON OF ULTRAVIOLET LAMPS JULY 21 TO SEPTEMBER 6, 1934

Lamp	30-watt G-1			
	Standard clear	Lime glass clear	Purple corex	Mercury-vapor tube
Moths per day	7.13	4.86	10.36	14.09

The special G-1 lamps varied from the standard G-1 clear only in the bulb. That with the lime glass bulb radiated little ultraviolet light (Table 1) and more visible light than the standard or purple corex. On the other hand, the purple corex G-1 radiated practically no visible light, but exceeded the standard in ultra-violet radiation (Table 1). Energy radiated by the mercury-vapor tube is considerably less than for any of the G-1 lamps, according to measurements made in the laboratory of the General Electric Lamp Works.

Illumination from these lamps was measured while they were installed in the electrocuting traps at a distance of one foot from the center of the lamp with a Weston illuminometer equipped with a green filter. The readings in foot-candles for the various lamps were: G-1 standard clear, 3.0-3.5; G-1 purple corex, 0; G-1 lime glass, 8.0-8.5; mercury-vapor tube, 1.5-2.0.

There is little difference between the Mazda C and the CX lamps, but when the blues or violets are compared with them, the blue or violet remain well in the lead. This was found to be the case by Runner (5) in his work with the tobacco beetles, by Herms (10) with the grape leafhopper, and by Theobald (6) in working with stable flies.

Lilly (4), in his studies with the cherry case bearer, found that 80 per cent of the adults caught were females, and Herms (10) found that lights of a "midnight blue" color attracted 8 female grape leafhoppers to each male. Data in Table 5 show the percentage of female codling

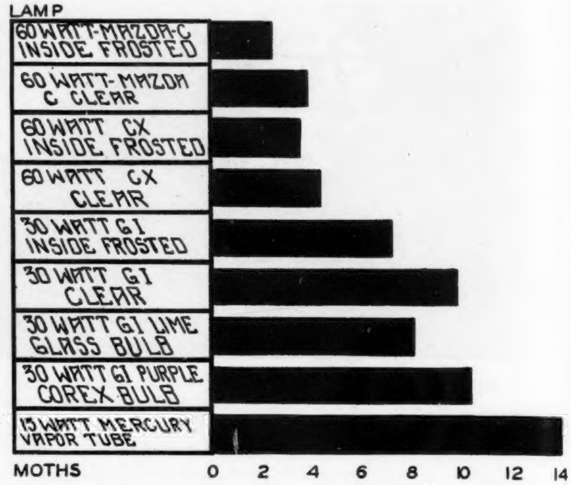


Fig. 8 This graph shows the codling moth catch per trap per day for the majority of the lamps used in the 1934 experiments

moths attracted by the different kinds of lamps in the orchard. Results indicate that the clear bulbs are effective in increasing the ratio of females to males caught in the traps.

TABLE 5. PERCENTAGE OF FEMALE CODLING MOTHS ATTRACTED BY VARIOUS LAMPS

Lamp, type	Females, per cent	Lamp, type	Females, per cent
Mazda C, IF	30.7	G-1, limeglass	37.6
Mazda CX, IF	32.7	G-1, purple corex	40.2
G-1, IF	32.0		
Mazda C, clear	36.7	Mercury-vapor tube	31.0
Mazda CX, clear	36.9		
G-1, clear	33.1		

The exact location of a trap makes a very considerable difference in the catch as shown by figures obtained by adding the daily catches for each of the six positions of the two wheels. Positions are given in the accompanying table in degrees measured clockwise from north. The axle of the wheel was over the center of the tree. The daily catch for each position throughout the season is listed in Table 6.

TABLE 6. EFFECT OF LOCATION OF TRAP ON CODLING MOTH CATCHES

Position Number	Moths per day: Wheel A	Moths per day: Wheel B	Position in relation to north, Degrees
1	6.00	6.80	0
2	6.10	5.50	60
3	6.01	4.90	120
4	6.53	4.10	180
5	8.65	4.20	240
6	9.36	4.90	300

A third series of six traps was put in a field 320 ft wide. The traps were placed in a line 20 ft apart and 12 ft from the ground in the center of this pasture and parallel to the tree rows bordering it. Thus the first row of trees on either side of these traps was a distance of about 160 ft. The per trap per day catches of *(Continued on page 371)*

A Rural Electrification Survey[1]

By David S. Weaver[2]

A STUDY to determine the most effective ways in which the agricultural engineering department of North Carolina State College could assist in the emergency relief work in North Carolina pointed the way to what finally resulted in a state-wide survey of the possibilities of extending electric service to the rural sections. To even the casual observer, the CWA program showed one outstanding weakness, namely, the lack of carefully planned projects of permanent economic value. Undoubtedly, taken as a whole, the CWA program was successful in its prime purpose, that of providing immediate employment. But how much greater its accomplishments could have been, if careful, long-time planning could have been given to each and every project before it was undertaken.

Several circumstances contributed to the formation of our survey project:

1 Two short rural extensions from municipal systems were built with CWA funds supplemented by local contributions.

2 The three-county rural electrification survey which had been stimulated by the federal rural housing survey.

3 The interest of Governor Ehringhaus and the state Grange.

4 The availability of FERA funds for carrying out the survey.

As director of the three-county survey and with the help of Mr. George W. Kable, then connected with the U. S. Bureau of Agricultural Engineering, the author was able to focus the attention of the governor on the timeliness of a state-wide survey of the possibilities of rural electrification in North Carolina.

Through the cooperation of Mrs. Thomas O'Berry, the able administrator of the ERA in North Carolina, and the state relief committee, headed by Dr. Howard Odum, funds were made available, and the governor appointed a committee on rural electrification. The chairman of the committee is the well-known Dr. Clarence Poe, editor of THE PROGRESSIVE FARMER. Thirteen other outstanding rural leaders of the state were included, representing the agricultural extension service, the vocational agricultural department, the department of conservation and development, the highway commission, and the state Grange. The author was chosen as director of the project.

The above-mentioned events took place over a period of three months, and public interest was steadily mounting so that newspaper accounts of the appointment of the committee resulted in applications for surveys to be made in 137 communities. With this as a basis the program was built on a 150 community survey. But before a month had passed, it was realized that we had greatly underestimated the whole problem, and we finally extended the survey to cover 677 communities; and there is evidence that, if time and money factors had not entered the picture, well over 1200 communities would have been included.

The interest of the state ERA in the survey centered chiefly on the possibility of using relief workers in the survey itself, and in the construction work on the proposed lines which it was considered feasible to extend. Clearance of right-of-ways; felling, preparing, and transporting of poles, and line erection were all considered as a source of jobs for relief labor. Many obstacles in the way to using this type of labor on these projects, together with the problem of pole preservation have been encountered, and these problems are as yet unsolved, it being the concensus that the survey must be completed and studied befo:e definite work projects in construction could be planned.

There are 100 counties in North Carolina ranging from the coast to the mountains, and the survey was planned to cover requests from communities in 75 of these counties. Before we were through with the field work, however, communities in 78 counties were included. The 22 counties not included were largely in the mountains.

The men selected for the field work, of necessity, had to come from relief rolls, but contrary to some expectations we were able to secure fairly competent men in general, nearly all of them having had some electrical experience, and some were graduate engineers. There were 58 of them, and they averaged about 9½ weeks in a county, although the range was very great. Some of these men covered as many as six counties, but in most cases only one county. They were paid 80 cents per hour for 30 hours per week, but actually worked nearly twice that. Their interest was remarkable and reflects the state-wide attitude toward the problem. Many interesting sidelights were reported. A travel allowance of four cents per mile and a limit of 900 miles (on the average) was available and, in most cases, sufficient. No other expenses were allowable. The men were furnished with measuring tapes, pencils, inch-to-the-mile scale county maps, and a celluloid scale containing symbol forms for the various classifications of rural users. All lines—transmission, distribution, and proposed—were shown in different colors as well as substation and generating plants. Each proposed customer was indicated by the proper symbol and all measurements shown. In many cases thickly populated areas had to be shown on an enlarged scale.

In addition to the information given on the maps, data on existing transmission and distribution lines was collected as follows: voltage, phase, wire size and material, effective spacing, cycles, length, and power factor. On existing substations the voltage, primary and secondary; total kva (kilovolt-amperes) capacity and estimated maximum demand in kva for the year 1934. Other data included right of way—cleared or timbered—if title would be donated, and amount of contributions in poles, labor, and cash. Some information on telephone possibilities was also collected, but is temporarily being eliminated from our estimates. Proposed customers' data were obtained on the following items: Name, distance from beginning of line in feet; whether owner or tenant, white or colored; number of rooms and regular occupants of home; other buildings to be lighted. If following equipment and appliances would be used: Refrigerator, water system, washing machine, iron, range, motors and size thereof, radio, and miscellaneous household appliances—also number of acres in cotton, tobacco, truck, fruit, and general, and number of head of dairy cattle, hogs, and poultry. Included were two columns for private rating of the condition of the premises and reliability of the interview. These were made by the field man from his obser-

[1]Paper presented at a session of the Rural Electric Division during the 29th annual meeting of the American Society of Agricultural Engineers at Athens, Georgia, June 17 to 20, 1935.

[2]Professor of agricultural engineering, North Carolina State College, and project director of the North Carolina Rural Electrification Survey. Mem. ASAE.

RELIABILITY RATING

	Condition of Premises															
	A	A	A	A	B	B	B	B	C	C	C	C	D	D	D	D
	Rating of Interview															
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
(1)	1.000	.950	.900	.850	.900	.855	.810	.765	.800	.760	.720	.680	.700	.665	.630	.595
(2)	.900	.855	.810	.765	.810	.770	.729	.689	.720	.684	.648	.612	.630	.599	.567	.536
(3)	.850	.808	.765	.723	.765	.727	.689	.650	.680	.646	.612	.578	.595	.565	.536	.506
(4)	.800	.760	.720	.680	.720	.684	.648	.612	.640	.608	.576	.544	.560	.532	.504	.476

(1) white owner; (2) white tenant; (3) negro owner; (4) negro tenant

vation and all of the information was discounted accordingly as shown by the above table.

(NOTE: Copies of the forms used in this survey may be obtained by writing the author at State College Station, Raleigh, N. C.)

In most counties, the farm and home demonstration agents and the teachers of vocational agriculture gave liberally of their time to assist the field men in securing the data for their counties. Community meetings were held and the purposes of the survey were explained. One county, Orange, has used the data obtained to outline an independent project which received special attention at Washington, and a line 10.5 miles long serving 40 customers is now near completion. There is some possibility that it may secure still further funds to make it a "yardstick" for other counties. Certain favorable conditions existing in this county, however, are probably not to be found elsewhere in the Southeast.

There are seven privately owned electric power companies operating in North Carolina, and they have given excellent cooperation in the way of supplying data on existing lines. That their interest is more than passive is quite evident, but due to the evident feeling of the federal government, they have, for the most part, adopted the attitude of watchful waiting. But while waiting they have decided some of our proposed extensions were not so impractical as they once believed, and almost without exception are constructing some extensions. The total mileage built or being built is estimated at 75 miles serving 456 customers. In addition, there are some 65 municipally-owned distribution systems in the state, quite a few of which generate their own electricity. Some outstanding examples of the possibilities of municipal ownership are to be found here. In most cases these municipalities are willing to extend lines to surrounding rural sections if satisfactory financial plans can be developed, and there are 112 miles built or being built by these cities. One municipality has 53 miles under construction and reports 15 per cent more "signed-up customers" than were interested six months ago.

The field data was digested and individual line calculations have been made by an office force of six workers. Eight students using college FERA funds did the copying of the maps and data in the 15 copies of our complete report. Because of the necessity of an immediate report for consideration by the state legislature then in session, an analysis of only those lines showing six or more customers per mile was rushed to completion, and the remaining lines were completed June 10 of this year. This was quite a task, requiring about five minutes to the customer, and with about 25,508 customers the amount of work is evident.

The complete report includes a book of county maps showing all existing electric line locations and data as well as the proposed extensions. Statistical data on each line by counties is included as follows: Location in county; length of line and branches, miles; total number of interested prospects; interested prospects per mile; estimated connected load, kilowatts; connected load, kilowatts per mile; estimated cost of line; cost per mile; cost per prospect; estimated annual revenue; annual revenue per mile; annual revenue per prospect; estimated annual consumption, kwh (kilowatt-hours); annual consumption per mile, kwh; annual consumption per prospect, kwh; estimated cost of line material; estimated annual revenue; estimated cost of line; estimated annual revenue. The total cost of this survey was approximately $22,000, the original allotment of $8,500 being supplemented from time to time as the work expanded.

Despite numerous newspaper articles and as widespread information as it is possible to give, the general impression is out that our committee is building the lines. As mentioned above several of our proposed lines are being built by power companies or by cooperative groups. Articles on these have appeared and immediately floods of letters, telegrams, and committees are sent to our office to see why some lines have been given preference. Certain areas have attempted to bring pressure to secure preference, but so far we have been able to ignore it. When general construction begins it is obvious that some lines will have to be built first, and then our troubles along this line will really begin.

Surveys of 677 requested extensions have been made. These aggregate 4487 miles and about 25,508 customers have been interviewed, of which 22,779 have displayed active interest in securing electrical service. This is an average of about 5.08 interested customers per mile for the state as a whole. There were about 195 lines showing six or more customers per mile. This was the figure used as

BREAKDOWN OF DATA SECURED

Counties in state	100
Counties surveyed	78
Number of personal interviews	25,508

	Interested	*Not interested*
Residences	19,953	2,599
Total rooms in residences	128,573	8,846
Filling stations	1,022	20
Schools	283	11
Churches	764	20
Miscellaneous	801	35
Total population	90,849	6,603

NUMBER OF OTHER BUILDINGS TO BE WIRED

Barns	5,905
Poultry houses	915
Garages	1,808
Miscellaneous	2,068

NUMBER OF LARGE APPLIANCES IN WHICH PROSPECTIVE CUSTOMERS DISPLAYED AN ACTIVE INTEREST

Refrigerators		6,540
Washing machines		3,281
Ranges		977
Water systems	Family	4,541
	Livestock	1,343
	Miscellaneous	705
Other motors		9,194 hp

NUMBER OF SMALL APPLIANCES IN WHICH PROSPECTIVE CUSTOMERS DISPLAYED AN ACTIVE INTEREST

Miscellaneous heating appliances	8,027
Miscellaneous motor-driven appliances	2,190

DATA ON EXISTING HOME AND FARM LIGHTING PLANTS OWNED BY PEOPLE INTERVIEWED ON THE SURVEY

	Interested	*Not interested*
Electric plants	1,939	30
Gas plants	735	35

the lower limit in making a preliminary estimate. A new figure, 3600 kwh per mile per year has been suggested by the Washington office as an index of feasibility. One hundred forty lines as they now stand show this or a greater consumption, and at least 60 to 70 others could conform by dropping off weaker branches or ends.

The 1935 North Carolina General Assembly has passed two bills which are really enabling acts to further the project. The bills provided for the appointment of a permanent commission of six members. This commission has just been appointed with a full-time chairman and secretary and an operating fund, and it will begin to function at once. The chief function of this commission will be to determine the feasibility of making extensions in conformity with the federal Rural Electrification Authority's plans. At present indications are that the problem will be attacked by districts. One such district, composed of three counties, has presented its application to the commission.

Lines will be constructed where the revenue will justify them. A monthly charge will be made above the cost of the current. This charge will vary with each line (or at least with each district) and be sufficient to retire the bonds and provide a sinking fund.

The electric utility companies have held that a line is not profitable for them unless it is of the so-called 3-to-1 basis or better. That is, the cost of the line should not be over three times the annual gross revenue. Under the plan contemplated in the bill, it is hoped that this can be changed to a figure as low as 5 or even 6 to 1. This whole problem is very complex, and time alone will reveal how it should have been worked out. An historian has a much easier job than a prophet.

We know the usual obstacles placed in the path of such a movement as we have started. We know the history of the "pull the switch and go back to wood and kerosene in times of low farm prices." We know that a farmer with three or four 25-watt lights thinks he is on Broadway after years of kerosene lamps and that he cannot see why he will have to use more current if he is to get electric service. But in spite of all these and a hundred other obstacles, rural electrification is coming, and with every important factor lined up in its favor. The iron is hotter than it has ever been, and *now is the time to strike it.*

That our program is being watched is evident. A good many states, following the order from Washington to all state ERA administrators to inaugurate a similar survey, have written in for our method of procedure. We not only gladly furnish it, but have prepared a list of changes which we would make if called upon to conduct a second survey, and there is evidence that a supplementary survey to cover additional communities may have to be made. We have made a lot of mistakes and other states will doubtless make more complete surveys, but we are very much gratified with our progress so far.

Light Traps for Codling Moth Control

(Continued from page 368)

moths, made during the season by the seven lamps studied, are listed in Table 7.

TABLE 7. CODLING MOTH CATCHES AT 160 FEET DISTANCE FROM ORCHARD

Lamp	200-watt Mazda C, clear	60-watt Mazda C, clear	60-watt CX, clear	60-watt CX, inside frosted	30-watt G-1, standard, clear	30-watt G-1, limeglass	Mercury-vapor tube
Moths per day	0.61	0.36	0.32	0.45	0.95	0.33	0.20

Inspection of this table reveals that but very few moths were drawn out of the orchard, those caught probably representing the natural migration.

A fourth series of six traps was placed 6 ft apart and 40 ft from the first row of trees in the orchard. The traps were hung 15 ft above the ground. A white oilcloth screen 4 ft wide and 18 ft long was placed back of the traps as shown in Figs. 6 and 7. Back of three traps the screen was white oilcloth, and back of the other three it was painted with several coats of aluminum paint, since this paint is used for reflecting ultra-violet light. With this installation any additional attraction brought about by one reflector or the other would be easily noted in the catch. The per trap per day catches for the two reflecting screens are shown in Table 8.

TABLE 8. CODLING MOTH CATCHES USING WHITE AND ALUMINUM REFLECTORS

	Lamp		
Screen	60-watt Mazda C, clear	60-watt Mazda CX, clear	30-watt G-1 standard, clear
White	0.04	0.20	0.33
Aluminum painted	0.20	0.16	0.12

It would seem from this table that the aluminum-painted screen was of little value in making the light sources more attractive, and also that the lamps were not attractive enough to entice moths from the orchard 40 ft away. Three of the lamps were operated for a time without any screen, while the other three had the oilcloth back of them. The catch was greater in traps without a background. The data reported are submitted as a progress report because of the present interest in the use of electrocuting traps.

BIBLIOGRAPHY

(1) *Borden, Arthur D.* 1931. SOME FIELD OBSERVATIONS ON CODLING MOTH BEHAVIOR. Univ. of Calif., Col. of Agr., Agr. Expt. Sta. Prog. Rpt. No. 16, Reprinted from Jour. of Econ. Ent., Vol. 24, No. 6.

(2) *Peterson, Alvah, and Haeussler, G. J.* 1926. THE ORIENTAL FRUIT MOTH. U. S. Dept. of Agr. Dept. Circ. 395.

(3) *Collins, Donald L.*, and *Nixon, Maurice.* 1930. RESPONSE OF LIGHT OF THE BUD MOTH AND LEAF ROLLER. N. Y. St. Agr. Expt. Sta. Bul. 583.

(4) *Lilly, J. H.* 1933. WORK WITH ECONOMIC INSECTS AT THE WISCONSIN STATION. Univ. of Wisc., Agr. Expt. Sta., Bul. 425.

(5) *Runner, G. A.* 1917. THE TOBACCO BEETLE AND HOW TO PREVENT DAMAGE BY IT. U. S. Dept. of Agr. Farmers' Bul. 846, pp. 18.

(6) *Theobald, Fred V.* 1926. INSECTS CAUGHT IN LIGHT TRAPS. Jour. Royal Hort. Soc., Vol. 51, Pt. 2, pp. 314-323.

(7) *Headlee, T. J.* 1932. FURTHER STUDIES ON THE ELECTROMAGNETIC WAVES OF INSECTS. Jour. of Econ. Ent., Vol. 25, No. 2, pp. 276-288.

(8) *Herms, W. B.* 1932. DETERRENT EFFECT OF ARTIFICIAL LIGHT ON THE CODLING MOTH. Univ. of Calif. Hilgardia, Vol. 7, No. 7.

(9) *Herms, W. B.* 1929. A FIELD TEST OF THE EFFECT OF ARTIFICIAL LIGHT ON THE BEHAVIOR OF THE CODLING MOTH, CARPOCAPOA PAMONELLA-LAVIN. Univ. of Calif. Prog. Rpt. No. 12, reprinted from Jour. of Econ. Ent., Vol. 22, No. 1.

(10) *Herms, W. B.*, and *Ellsworth*, J. K. 1934. FIELD TESTS OF THE EFFICACY OF COLORED LIGHTS IN TRAPPING INSECT PESTS. Jour. of Econ. Ent., Vol. 27, No. 5.

NEWS

North Atlantic Section to Meet at Cornell

AS PREVIOUSLY announced, the next yearly meeting of the North Atlantic Section of the American Society of Agricultural Engineers will be held at Cornell University, Ithaca, N. Y., October 7, 8, and 9 with the agricultural engineering staff of the state college of agriculture as hosts for the occasion. It is of interest to note in connection with this event that the organization meeting of the section was held just a decade ago at Ithaca, in April 1925.

As this issue goes to press, the program for the meeting is still in tentative form, so far as speakers are concerned. However, a number of subjects of timely interest to agricultural engineers, particularly of the states of the north Atlantic seaboard, will be featured on this program.

The sessions will be held on the agricultural college campus, with meeting headquarters at the agricultural engineering department.

The meeting will open Monday forenoon, October 7, with an address by the chairman of the Section, F. L. Fairbanks, professor of agricultural engineering, New York State College of Agriculture. In addition, the subjects to be featured at this session will include farm electric service work in the Central Hudson Valley, the present activities in soil conservation in the northeast states and new farm machinery developments.

The group attending the meeting will be officially welcomed on behalf of the University at the opening of the afternoon session by Dr. C. E. Ladd, dean of agriculture and director of the agricultural experiment station. Three subjects, including the county engineer, land-use planning in the Northeast, and farm fires from alfalfa will be the topics for the remainder of the afternoon program.

The evening of the same day will be devoted to two coincident round table sessions, one devoted to rural electrification, and the other to farm machinery.

The forenoon session of Tuesday, October 8, will feature three subjects, including new developments in applying fungicides, writing bulletins, and the Tompkins County (N. Y.) Development Association.

The afternoon program for the same day will start out with two papers, one on the subject of engineering the farmer's dollar, and the other on agricultural engineering and vocational education, after which three coincident round table sessions will be held, including one on rural electrification, one on farm structures, and the third on agricultural engineering teaching.

Following the afternoon program a ball game will be staged, after which the group will attend the banquet in the evening, which is one of the important features of North Atlantic Section meetings.

Two subjects—low cost farm wiring and ensiling legumes—will feature the program for the forenoon session of Wednesday, October 9. Following this the group will leave in busses and automobiles for Geneva (40 miles from Ithaca) for the purpose of unveiling a monument commemorating the laying of the first drain tile in the United States just one hundred years ago, on the farm of John Johnston located near Geneva. Articles by B. B. Robb and J. R. Haswell on Mr. Johnston and the laying of the first drain tile in America will be found elsewhere in this issue.

Washington News Letter

AMERICAN Engineering Council reports the following news from Washington of particular interest to engineers for the month ending August 15:

Numerous projects under the work relief program have been approved over the past month. Now that allocations of funds have been made to operating units and the general organization of the program has taken form in Washington and in the field, the program is developing toward a peak in field operations scheduled for about November. Most of the agencies entering the work relief picture have fairly well outlined their procedure and have worked out lines of cooperation with other agencies. Much of the apparent delay is now developing into what seems to be better planning, which utilizes experience gained in recent years and should tend to eliminate waste and confusion.

The Works Progress Administration is looking ahead to next winter and is seeking carry-over projects for its employes displaced from construction work by weather conditions. The purpose is to provide continuous work for all relief employes.

Another interesting development is the introduction of RFC into the rural electrification program by way of a reorganized Electric Home and Farm Authority which will loan RFC funds to farmers for electrification of their homes, farms, and cooperative enterprises.

Applications for new non-federal projects are being received by the PWA under the new plan of 45 per cent federal grants and 55 per cent loan at 4 per cent interest, revised from the 30 per cent grant and 70 per cent loan at 4 per cent formerly in effect. After a project has been approved, 15 per cent of its cost may be made available for plans and surveys.

The Federal Housing Administration has raised its limitation on modernization credit from $2,000 to $50,000. This lets in jobs big enough to employ engineers. Regulations have been liberalized as to purchase of machinery and equipment.

The National Youth Administration, newly organized as reported in the last letter, has announced that its aid to high school and college students from relief families will take the form of part-time work.

Special surveys planned by the Bureau of the Census may be of interest especially to engineers not physically able to do field work. A census of business during 1935, covering all fields except manufacturing and agriculture; a national survey of retail trade; and an alphabetical index of all individuals included in the Census of 1900 are among the projects recommended.

A dinner meeting in honor of John Monroe Johnson, newly appointed Assistant Secretary of Commerce, was held on the evening of July 30 at the invitation of J. F. Coleman, president of Council. Mr. Johnson is a member of the ASCE and since 1898 has been in engineering practice at Marion, S. C. During the World War, he served as a colonel and chief engineer of the Rainbow Division; later was chairman of the S. C. State Highway Commission. The dinner was attended by resident officers of member organizations and members of the Assembly of Council. Presidents of local sections of founder societies in attendance were: Gen. R. C. Marshall, ASCE; Harvey L. Curtis, AIEE; and Morris Weschler, ASME. Col. Donald H. Sawyer, vice-president of the ASCE, C. H. Spencer, president of the Washington Society of Engineers, and L. F. Livingston, new president of the American Society of Agricultural Engineers, also attended.

Executive engineers from WPA, PWA, RA, REA, and other federal agencies met with President Coleman and Council's staff at a luncheon July 30.

"Mapping for National Planning" is the title of a pamphlet being distributed in a limited edition by the ASCE among public officials and business executives in order to stress the importance of good surveys and accurate topographic maps in the utilization of natural resources and in the everyday planning of community, industrial, and commercial undertakings. Prepared with the advice and aid of recognized authorities on mapping, the pamphlet describes the inadequacy of existing maps, the uses of maps, the present mapping program, and a future program designed to meet the needs.

A program for accrediting engineering schools in New England and the middle Atlantic states has been announced by the Engineers' Council for Professional Development. After a trial period in these regions, the program will be offered to the other parts of the country. Regional subcommittees have been set up to visit each institution requesting recognition. The visits will begin early in the fall. Accrediting is deemed essential, especially in view of engineering licensing laws in states where graduation from accredited colleges is a partial requirement of licensure.

The Third Machine Tool Congress meets in Cleveland, September 11 to 20, under joint auspices of the ASME, SAE, American Society of Tool Engineers, National Machine Tool Builders' Association, and the Cleveland Engineering Society. The well-rounded program of discussions and inspection trips is expected to attract upwards to 25,000 people. All members of Council have been extended a cordial invitation by C. J. Thomas, secretary of the Cleveland Engineering Society, to make the society's office (410 Hanna Bldg.) their headquarters during the convention. The evening meeting of Sept. 16 has been assigned to the Cleveland Engineering Society and will feature a talk by W. S. Knudsen, executive vice-president, General Motors Corp., on the subject "Look to the Foreman." The

machine design division of the Cleveland Society will sponsor the evening meeting of Sept. 17 when Guy Hubbard will talk on "Tomorrows' Machine Tools."

* * * *

The following news from American Engineering Council, dated August 31, is of special interest to agricultural engineers:

All engineers interested in rural electrification should know that the bill to continue the Electric Home and Farm Authority failed to get favorable action in the last hours of Congress. The Electric Home and Farm Authority had been re-incorporated in the District of Columbia and its offices were to be transferred to Washington. With proper supporting legislation it would have been set to lend Reconstruction Finance Corporation funds for the electrification of farms and rural industries. In the absence of that legislation, the future of this important adjunct to the Rural Electrification Administration is very uncertain.

Several bills enacted during the past session of Congress will require entirely new administrative staffs under the newly created federal agencies. These include social security, the Guffey coal bill, the holding company bill, the motor carrier bill, and others of less importance. The failure of the third deficiency bill at the close of the session, however, brought about complications in the financing of these measures which may even delay their completion until the next session of Congress. Interested engineers should establish contacts with these agencies, however, in order to be in line for consideration.

All recent moves of the Administration regarding the work relief program indicate more authority and responsibility for the decentralized staffs of the Public Works Administration, the Works Progress Administration, and other administrative agencies in the states. Each step in that direction makes it easier for engineers handling projects or applications for projects to reach responsible authorities.

As the program gets under way there will be new rules and regulations and changes to old ones. The need for them will develop from experience and some of them will come from new legislation passed by the last Congress. In many instances the interpretations of discretionary power granted by Congress may be of even greater importance than the wording of the acts themselves.

Necrology

MAJOR O. V. P. STOUT, 1865-1935

OSCAR VAN PELT STOUT, irrigation engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, passed away August 4 at Denver, Colorado. Major Stout was elected to honorary membership in the American Society of Agricultural Engineers in 1928, and in 1932 he was awarded the first Cyrus Hall McCormick Gold Medal for "exceptional and meritorious engineering achievements in agriculture."

Major Stout was born in Jerseyville, Illinois, in 1865, but was reared in Nebraska and graduated from the high school at Beatrice. In 1888 he received his bachelor's degree in civil engineering from the University of Nebraska, and later served as city engineer of Beatrice. In 1892 returned to the University as instructor in civil engineering, and he was placed in full charge of that department in 1893. He became the University's chief advocate and, in 1895, its first teacher of agricultural engineering. He was granted his professional civil engineering degree in 1907 and was made dean of the college of engineering at the University in 1912, which position he gave up in 1920 to follow his chosen specialty, irrigation engineering. During 1918-19 he served as Major of Engineers in the U. S. Army.

Major Stout was largely responsible for the introduction of agricultural engineering into the curriculum at the University of Nebraska, for its gradual development into an independent department of the University college of engineering, and for the inspiration and development of its subsequent leaders and of men who carried his influence out to other states. It was in partial recognition of the debt which the agricultural engineering group owed him that he was elected an honorary member of the Society and four years later awarded the first Cyrus Hall McCormick Medal.

Major Stout's activities with the U. S. Department of Agriculture date back to 1899 when he served as engineer and consultant in irrigation and drainage investigations. From 1922 until recently he was employed on cooperative irrigation investigations in California, and at the time of his passing was detailed on special work to the U. S. Reclamation Service. He invented the proportional weir, a device for measuring irrigation water, and was the author of many reports and bulletins on irrigation.

He was a member of Phi Beta Kappa, honorary scholastic fraternity; Sigma Xi honorary scientific fraternity; Sigma Tau, honorary engineering fraternity; the Society for the Promotion of Engineering Education, and the American Society of Civil Engineers. He is listed in "Who's Who in Engineering," and in June 1932 the University of Nebraska conferred upon him the honorary degree of doctor of engineering.

As an educator Major Stout has inspired and shown the possibilities of agricultural engineering to his many students, four of whom have since served terms as president of the American Society of Agricultural Engineers. His greatest achievement, from the standpoint of its influence on agriculture and agricultural engineering, is believed to be his extended and successful sponsoring of the principles of agricultural engineering as a field worthy of special academic and professional attention.

* * * *

WENDELL PIERSON MILLER, head of an engineering firm bearing his name, passed away at Tulsa, Oklahoma, August 13. He was elected to membership in the American Society of Agricultural Engineers in 1919, and was particularly active in the land reclamation group of the Society.

Mr. Miller was born in 1896 at Sunbury, Ohio, attended Ohio Wesleyan University and later Ohio State University, from which he received his degree in 1919.

He was one of the organizers, in 1918, of the Agricultural Engineering Service Company, with which also the late Frederick Walter Ives was connected, and upon its incorporation in 1919 he became its treasurer and the general manager. This company was one of the first of its kind to do a general practice in agricultural engineering. In August 1920 Mr. Miller became associated with the Ohio State University as agricultural engineering extension specialist, which position he held for four years and then resigned to again engage in practice as consulting agricultural engineer, specializing in drainage, irrigation, and farm building. Up until a few years ago he had built up an extensive business in engineering and construction work which was operated under the name of Wendell P. Miller and Associates. The business had suffered severely as the result of the depression, but during the present year had begun to pick up again rapidly and at the time of his passing he had several large golf-course construction jobs under way.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Edwin K. Bonner, Jr., assistant designer, John Deere Plow Works. (Mail) 421 26th St., Moline, Ill.

Roy D. Hauger, junior foreman, (ECW), Box 112, Lindale, Texas.

H. Wooster Horney, superintendent, Soil Conservation Service, U. S. Department of Agriculture. (Mail) RFD No. 1, High Point, N. C.

L. J. Lann, technical engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Ruston, La.

Robert E. Lewis, camp superintendent (ECW), Soil Conservation Service, U. S. Department of Agriculture. (Mail) Dublin, Tex.

John T. Mahone, technical foreman, jr. (ECW). (Mail) Jacksonville, Tex.

Lawrence C. Porter, illuminating engineer, General Electric Co., Nela Park, Cleveland, Ohio.

Andrew J. Urness, agricultural aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Highland, Wis.

H. M. Wallace, Jr., chief agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 1215 Court St., Muskogee, Okla.

O. C. Word, Jr., district supervising engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Stillwater, Okla.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

A PORTABLE SMALL GRAIN THRESHER. *A. G. Weidemann.* Jour. Amer. Soc. Agron., 26 (1934), no. 4, pp. 346-352, figs. 2. A small grain thresher, the basic principles of which were developed at the Michigan Agricultural Experiment Station, is described and illustrated.

UTILIZATION OF LOW-GRADE FUELS, COKE OVEN AND TAR OIL WASTES, *C. A. Basore.* Ala. Engin. Expt. Sta. Bul. 5 (1934), pp. [4] + 40. This publication presents a discussion of newer methods for concentrating and utilizing low-grade and waste coals, lignite, and peat. Information also is presented on the utilization of wastes relative to the coking of coals and the refining of coal tar oils. A complete bibliography containing a large number of references is included.

GROWING POTATOES WITH TRACTOR POWER, *R. U. Blasingame.* Amer. Potato Jour., 11 (1934), no. 8, pp. 199-204, figs. 2. The results of experiments conducted at the Pennsylvania Agricultural Experiment Station on the growing of potatoes with tractor power are reported. The data presented relate to seedbed preparation, fertilizer distribution, planting, foliage protection, weeding and cultivating, and harvesting, and information also is presented on the machinery developments found necessary and on the power and labor requirements.

INVESTIGATIONS ON MACHINERY USED IN SPRAYING—I, NOZZLES, *C. Davis* and *G. R. B. Smyth-Homewood.* Jour. Southeast. Agr. Col., Wye, Kent, no. 34 (1934), pp. 39-62, figs. 12. The results of studies of spray nozzles are reported, the purpose being to ascertain the capabilities for performance of different types.

It was found that the smaller the disk orifice the smaller was the spray cone and the less was the carry. Variations in disk orifice also affected to some extent the thickness of the ring patterns. Variations in orifice diameter had no effect on atomization. Irregularities in the shape of disk orifices adversely affected the form of spray cones, and irregularities in the countersunk portion of the disks adversely affected the spray cones. Increases in the thickness of the disks decreased the diameter of the cones and decreased the atomization, increases in pump pressure increased atomization, carry, and back pressure, and altered the diameter of the cones, and increases in eddy-chamber depth increased carry, output, and back pressure and decreased atomization and diameter of spray cones. Increases in size of vortex openings, whether holes or channels, increased carry, output, and back pressure, and decreased atomization and diameter of cones, and irregularities in the shape or disposition of vortex openings tended to produce spray patterns heavier on one side, or in parts, than the other. The symmetry of the spray cones was better at distances of 3 ft and less; beyond this the stationary patterns generally lost their regular shape. Losses of spray liquid, caused by gravity and air resistance, occurred at distances from the nozzles which varied with variations in those factors governing carry. In the main, the greater the carry the less the loss at given distances.

The advantages of higher pressure (from 400 to 800 lb per square inch) than are usually employed were greater output, increased carry, and better atomization. The disadvantages were increased losses due to leaks, breakdown of parts not designed to deal with the greater stresses, and a loss of symmetry and uniformity in the spray cones. This seems to point to the desirability of having nozzles especially designed for high-pressure work.

FRENCH MOTOR TILLAGE DEMONSTRATION. Impl. and Mach. Rev. 60 (1934), no. 715, pp. 584-587, figs. 3. A brief account is given of the annual demonstration of motor tillage machines organized by the Chambre Syndicale de la Motoculture and the Ministry of Agriculture.

ASTM TENTATIVE STANDARDS, 1934. Philadelphia: Amer. Soc. Testing Materials, 1934, pp. XXVIII + 1257, pl. 1, figs. [191]. This number of this book contains 236 tentative specifications, methods of testing, definition of terms, and recommended practices covering materials of engineering and the allied testing fields. Of these 236 tentative standards, 25 relate to ferrous metals, 25 to nonferrous metals, 48 apply to cementitious, ceramic, concrete, and masonry materials, 127 cover miscellaneous materials such as paints, petroleum, insulation, textiles, etc., while 11 are general testing methods applying to these materials.

SYSTEM OF CLASSIFICATION FOR AGRICULTURAL ENGINEERING MATERIAL, *S. von Frauendorfer.* [Internatl. Rev. Agr.], Mo. Bul. Agr. Sci. and Pract. [Roma], 25 (1934), no. 9, pp. 393-411. A classification system of agricultural engineering is presented which is part of a wider and more complex system, embracing all branches of agriculture. The system is intended to form a basis for a bibliography of agriculture which is to include a systematic subdivision, not only of technical literature but also the contents of periodicals.

THE DISTRIBUTION OF SOIL PRESSURE BENEATH A FOOTING, *F. E. Giesecke, W. H. Badgett,* and *J. R. D. Eddy.* Tex. Engin. Expt. Sta. Bul. 43 (1934), pp. 15, figs. 8. The results of observations of soil pressure distribution beneath a column footing of reinforced concrete 19 ft square and 2.5 ft thick are presented. The soil beneath the footing is a clay with small and varying amounts of sand and coarse material. Under certain moisture conditions the soil will change to a very plastic or semi-liquid state and work up into open joints in foundations. Upon drying, the soil shrinks materially. In field tests the soil appeared to have considerable elasticity.

Laboratory tests of the soil showed that when the moisture content was 60 per cent or more a pressure of 300 lb per square foot caused free liquid to appear on the surface of the soil within 18 hr after application of the pressure.

The largest load was indicated at the center of the footing until the building above was practically completed when there was a gradual shifting of the maximum load toward one side. It appears that the pressure under the footing was never symmetrical about the column axis.

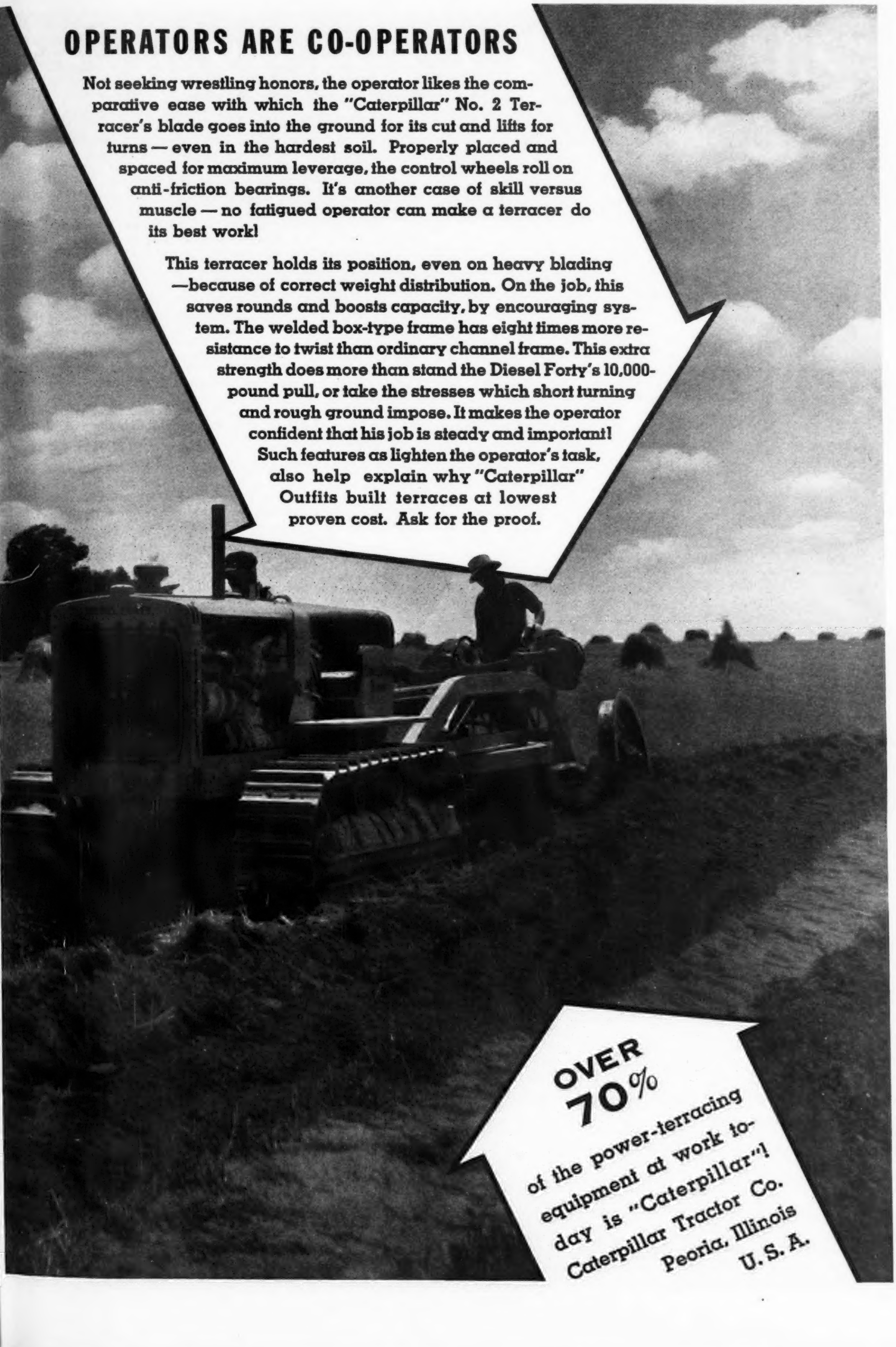
GROUNDWATER—I. FUNDAMENTAL PRINCIPLES GOVERNING ITS PHYSICAL CONTROL, *W. Gardner, T. R. Collier,* and *D. Farr.* Utah Sta. Bul. 252 (1934), pp. 40, figs. 23. This bulletin discusses fundamental principles governing the physical control of ground water and indicates applications. The mathematical background required in the presentation of the principles of the movement of ground water is presented in considerable detail.

It is shown that Newton's second law of motion, together with elementary hypotheses concerning frictional forces resisting the flow of water through soils, leads to Darcy's experimental velocity law generalized for flow in three dimensions. Applications are made to the solution of practical problems in the design of drainage structures, flow into wells, watershed erosion, leakage from canals, subirrigation, etc. A modified approximation form of Darcy's law is presented for the solution of problems in capillary flow.

WELDED JOINTS STUDIED WITH NEW TYPE POLARISCOPE. Engin. News-Rec., 113 (1934), no. 20, pp. 621, 622, fig. 1. A new type of polariscope developed in the photo-elastic laboratory of Columbia University is briefly described which makes possible photo-elastic studies of problems involving two parallel systems of plane stress, as represented by the stress distribution in the overlapping plates of side-welded connections.

USE OF FARM MACHINERY FOR CORN-BORER CONTROL IN THE ONE-GENERATION AREA, *R. M. Merrill.* U. S. Dept. Agr. Circ. 321 (1934), pp. 11, figs. 10. The results of experiments conducted by the USDA Bureau of Agricultural Engineering are briefly described. They indicate that one of the greatest aids to efficient control of the European corn borer by mechanical methods is the practice of level cultivation of corn. A cornfield left excessively ridged by cultivation is difficult to plow or rake cleanly and also handicaps somewhat the low-cutting harvesting machinery. Slightly ridged corn, however, does not offer these difficulties.

SLUM CLEARANCE AND REHOUSING: The first report of the Council for Research on Housing Construction. London: Council Res. Housing Construct., 1934, pp. 139 [pl. 1], figs. [48]. This is the first report of the English Council for Research on Housing Construction. *(Continued on page 376)*


OPERATORS ARE CO-OPERATORS
Not seeking wrestling honors, the operator likes the comparative ease with which the "Caterpillar" No. 2 Terracer's blade goes into the ground for its cut and lifts for turns — even in the hardest soil. Properly placed and spaced for maximum leverage, the control wheels roll on anti-friction bearings. It's another case of skill versus muscle — no fatigued operator can make a terracer do its best work!
This terracer holds its position, even on heavy blading —because of correct weight distribution. On the job, this saves rounds and boosts capacity, by encouraging system. The welded box-type frame has eight times more resistance to twist than ordinary channel frame. This extra strength does more than stand the Diesel Forty's 10,000-pound pull, or take the stresses which short turning and rough ground impose. It makes the operator confident that his job is steady and important! Such features as lighten the operator's task, also help explain why "Caterpillar" Outfits built terraces at lowest proven cost. Ask for the proof.
OVER 70%
of the power-terracing equipment at work today is "Caterpillar"!
Caterpillar Tractor Co.
Peoria, Illinois
U. S. A.

Agricultural Engineering Digest

(Continued from page 374)

CIVIL ENGINEERING HANDBOOK, edited by *L. C. Urquhart.* New York and London: McGraw-Hill Book Co., 1934, pp. VIII + 885, figs. [586]. This handbook contains 10 sections. Of special interest to agricultural engineers are those on surveying, mechanics of materials, hydraulics, stresses in framed structures, steel design, concrete, foundations, sewerage and sewage disposal, and water supply and purification.

THE ADJUSTMENT AND REPAIR OF GRAIN BINDERS, *M. A. Sharp* and *B. T. Virtue.* Iowa State Col. Ext. Circ. 209 (1934), pp. 16, figs. 7. Practical information is given on the subject.

TEMPORARY SILOS, *E. N. Shultz* and *B. T. Virtue.* Iowa State Col. Ext. Bul. 202 (1934), pp. 16, figs. 13. Practical information is given regarding the construction and adaptation of trench, corn cribbing, snow fencing, corn bundle, and other types of temporary silos.

INTERNATIONAL DIRECTORY OF AGRICULTURAL ENGINEERING INSTITUTIONS, *A. Brizi.* Les Institutions de Genie Rural dans le Monde. Roma: Inst. Internatl. Agr., 1934, 4. ed., pp. [7] + 185. This is the fourth edition of this directory. It covers practically the entire civilized world.

REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ENGINEERING, 1934, *S. H. McCrory.* U. S. Dept. Agr., Bur. Agr. Engin. Rpt., 1934, pp. 23. The progress results are presented of irrigation and drainage investigations and investigations of soil erosion control, farm land development, farm structures, and farm machinery. The greater part of this research program is conducted in cooperation with the different state agricultural experiment stations.

DISTILLATE BURNERS, *A. H. Senner.* U. S. Dept. Agr. Circ. 335 (1934), pp. 12, figs. 5. In a contribution from the USDA Bureau of Agricultural Engineering, practical information is presented on the distillate burner type of heating equipment which has been derived from the results of tests of burners of various designs. The operation of one type of distillate burner is described.

It appears to have been found that kerosene is preferable to No. 1 fuel oil as a fuel for distillate burners. Practical suggestions are made on the selection and care of equipment.

AGRICULTURAL ENGINEERING INVESTIGATIONS IN THE PAST TWENTY-FIVE YEARS, *A. L. Teodoro.* Philippine Agr., 23 (1934), no. 5, pp. 363-367, figs. 2. This a brief review of the outstanding results of agricultural engineering investigations at the University of the Philippines during the past quarter century. The outstanding investigation was that relating to the development of alcohol as an internal-combustion-engine fuel.

ANALYSIS OF A RIGID FRAME CONCRETE ARCH BRIDGE, *C. D. Geisler,* U. S. Dept. Agr. Misc. Pub. 184 (1934), pp. II + 16, figs. 8. This is a complex mathematical and structural analysis.

PHOTOELASTIC DETERMINATION OF TEMPERATURE STRESSES IN AN ARCH BRIDGE MODEL. *Z. Levinton.* Engin. Jour., 17 (1934), no. 12, pp. 513-517, figs. 9. After a brief account of the photo-elastic method of determining stress by polarized light, this paper describes a series of tests on a bakelite model of an arch of a bridge made to ascertain the stresses in the arch ribs and columns due to change of temperature. The experiments were conducted at the University of Saskatchewan.

It was found that the inherent error of the photo-elastic method is the inaccuracy in determining the stress values of the isochromatics. This error may easily reach 5 per cent, and where initial stresses are present is doubled. The error due to variation of optical effect with time after application of the load was found to be negligible at low stresses. On the other hand, the total error in determining the temperature stresses in the short columns was probably less than 20 per cent.

TRACTIVE RESISTANCE AS RELATED TO ROADWAY SURFACES AND MOTOR VEHICLE OPERATION, *R. G. Paustian.* Iowa Engin. Expt. Sta. Bul. 119 (1934), pp. 64, figs. 36. In this publication an analysis is presented of motor vehicle tractive resistance and air resistance. The relative merits of towing, decelerating, coasting, and direct methods of measuring tractive resistance are discussed, followed by a complete description of the gas-electric drive test car used in the investigation.

Data from road tests also are presented showing the effect of road surfaces on power requirements, gasoline consumption, and tractive resistance. The data show that the relative efficiencies of road surfaces vary widely. No one class of surfaces is stated to have either a high, average, or low efficiency because of the effect of differences in the surface condition. An outstanding finding was that constant throttle opening is accompanied by constant power output, regardless of the road profile.

THE LOSS OF HEAD IN CAST-IRON TEES, *F. E. Giesecke, W. H. Badgett,* and *J. R. D. Eddy.* Tex. Engin. Expt. Sta. Bul. 41 (1932), pp. 38, figs. 32. Studies are reported, the purpose of which was to determine the loss of head with water at 70 deg F flowing through standard cast-iron tees. The investigation included all possible combinations of flow in ¾-in, 1-in, and 1½-in standard cast-iron tees and in 1½-by-1¼-by-1-in standard cast-iron tees.

It was found that the loss of head in cast-iron tees is a function of the per cent of water diverted at right angles in the tee.

For practical applications the loss of head in cast-iron tees for the diverted portion of the stream, when expressed in equivalent elbows, may be calculated by the equation

$$E_e = 0.75\left(\frac{v_1^2 + v_2^2}{v_2^2}\right)$$

where E_e is the loss of head in equivalent elbows, v_1 is the velocity of the combined stream, and V_2 is the velocity in the portion of the stream diverted at right angles for which the loss of head is to be determined.

In most cases, for all practical purposes, the loss of head for the portion of water flowing straight through the run of the tee may be neglected.

HOUSES AND EQUIPMENT FOR POULTRY IN FLORIDA, *N. R. Mehrhof* and *F. Rogers.* Fla. Univ. Agr. Ext. Bul. 77 (1934), pp. 38, figs. 28. Practical information is presented on the construction of poultry houses and on different types of equipment to be used in the management of birds of various ages.

MODERN BEARING DESIGN, *L. M. Tichvinsky.* Machinery, 41 (1935), no. 5, pp. 265-270, figs. 4. A technical analysis is presented indicating how the allowable loads for plain or sleeve bearings are determined.

JOB ANALYSIS OF A RURAL SANITATION OFFICER: BRUNSWICK-GREENSVILLE HEALTH ADMINISTRATION STUDIES NO 2, *J. O. Dean* and *J. W. Mountin.* Pub. Health Rpts. [U. S.], 49 (1934), no. 51, pp. 1529-1543, fig. 1. In a contribution from the U. S. Public Health Service the duties of a rural sanitation officer are briefly described, with particular reference to water supply and excreta disposal. The analysis is based on the work of one officer in a rural health district containing 6,733 homes over a period of 6 mo. The sanitation program, which had been in operation for 10 yr, concerned itself almost exclusively with facilities for excreta disposal. Maintenance of privies was the major activity. Out of approximately 140 working days, 98 were devoted to privy sanitation, 31 to miscellaneous duties, and 11 were reported as off duty.

Among 1,468 premises visited for privy sanitation, 116 were found to have no excreta disposal facilities at all, 1,095 had privies of the insanitary class, 90 of the sanitary, and 167 of the approved class. During the visit first recorded for the study, the sanitation officer repaired 203 privies. Instructions were left with the owner or occupant to make the necessary changes at the remaining 1,098 premises. Revisits were made to 42 per cent of these premises, and at 134 the needed repair or construction was effected.

DYNAMICS OF EARTH AND OTHER MACROSCOPIC MATTER, *J. H. Griffith.* Iowa Engin. Expt. Sta. Bul. 117 (1934), pp. 152, figs. 39. This is a highly technical contribution in which dynamical unity and logical consistency with the established principles of mathematical physics are kept uppermost in connection with the development of theories for the behavior of earth and engineering substructures. The main subjects dealt with are the structural organization of matter; dynamical equations; lateral pressure of earth; analysis of retaining walls; tunnels, conduits, and other inclusions; the theory of piles and foundations; the theory of embankments; the hardness of matter; the theory of plasticity; and the degradation of energy and equilibria of heterogeneous matters.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE COLORADO STATION. Colorado Sta. Rpt. 1934, pp. 16, 17, 23, 24, 25. The progress results are briefly reported of tests by D. A. Wigle on evaporation of road oils in aggregates, tests conducted in cooperation with the USDA Bureau of Agricultural Engineering on sugar beet machinery, and of investigations on measurements of irrigation water by R. L. Parshall and pumping for irrigation and drainage by W. E. Code.

(Continued on page 378)

Agricultural Engineering Digest

(Continued from page 376)

Erosion Control Handbook: Project No. 14, Zanesville, Ohio. U. S. Dept. Interior, Soil Erosion Serv., [1934], pp. [3] + 69, figs. 21. This mimeographed handbook has been prepared by the staff of the Soil Erosion Service of the Salt Creek area and shows the general plan and organization of the Salt Creek watershed and presents information on gully control methods. These methods involve the use of engineering structures, trees and shrubs, and grasses and legumes. Numerous working drawings of gully control structures are included, together with engineering data.

Dry-Rot Investigations.—XI. Testing and Determining the Preservative Value of Fire Preventive Treatments for Wood, *R. Falck* and *V. Ketkar*. Hausschwammforschungen.—XI. Prufung und Schutzwertbestimmung der Feuerschutzmittel des Holzes. Jena: Gustav Fischer, 1934, pp. IV + 46, figs. 5; Eng. abs., pp. 39-46. An effort is made in this study to express the fire resistance of wood in one term, the purpose being to evaluate fireproofing treatments, particularly paints.

Data are presented on the determination of the ignition point and fire resistance of wood, on factors of combustibility and the effect of concentration of chemicals thereon, the preservative value of chemicals and fireproof paints, and resistance to washing out of some of the important fireproofing materials.

Fireproofing treatments for dry wood include a solution of arsenic and sodium carbonate, which has a fireproofing value of 60 per cent. A less effective treatment consists of a mixture of arsenic, boric acid, and sodium carbonate. A mixture of arsenic and boric acid is recommended for the fireproofing of wood partly exposed. A solution of zinc sulfate and arsenic also can be used for this purpose, but apparently is not so satisfactory.

For wood used in inhabited rooms, it is recommended that a solution of aluminum sulfate and boric acid be used, although a solution of boric acid alone has been found to have a fireproofing value of 50 per cent.

The use of portland cement and fluorides is recommended for the fireproofing of wood subjected to weather.

Electric Hotbeds for Propagating Woody Cuttings, *D. Wyman* and *M. W. Nixon*. [New York] Cornell Sta. Bul. 618 (1934), pp. 21, figs. 18. This bulletin describes and illustrates the planning and installation of electric hotbed equipment for propagating woody cuttings and reports the results of three years of investigations with deciduous and evergreen cuttings in which electrically heated and manure-heated beds were compared as to cost of operation.

The results show that electric hotbeds for use in the summer for rooting cuttings are practical. Where a large series of electric hotbeds is installed, these beds are much cheaper than a similar series of manure hotbeds when costs are considered over a period of years. The temperature can be regulated very closely in the electric hotbed when outside temperatures are lower than that required in the hotbed. Electric heat can be very effectively used in greenhouse benches to supply bottom heat for rooting cuttings. Complete and automatic control of greenhouse temperature and humidity is not economical at the present time, although it offers an excellent opportunity to maintain controlled conditions for experimental work in rooting cuttings. In general, it is not claimed that rooting is better in electric hotbeds than in manure hotbeds for all kinds of cuttings, particularly when several types of cuttings are being rooted in the same bed at the same time. In such cases the rooting may often be about the same in the two kinds of hotbeds.

Compressibility and Elasticity of Soils Indicated by Flocculation Constants, *C. A. Hogentogler*. Pub. Works, 65 (1934), no. 9, pp. 16-18, figs. 7. In a contribution from the USDA Bureau of Public Roads the results of studies are summarized which indicate that compressibility is the property which causes soils to deform vertically under load in proportion to the decrease in the air or moisture content. A compressible soil does not displace laterally, and the deformations are more or less permanent. Elastic soils, on the other hand, are difficult to compact and rebound upon the removal of load. They cannot be permanently compacted by rolling or other temporary application of load.

The total range in density combined with the density at particularly selected degrees of consolidation, shrinkage, and swell, indicate the extent to which the soils have the properties which control deformation. Consequently such densities are the basis of soil identification by means of physical tests.

The flocculation test is used as a means of measuring the physical tendencies of soils, such as cohesion, adhesion, drainage, and the like. This test consists of determining the porosity of soil samples in the dried and powdered state and at maximum water capacity in both the flocculated and deflocculated states.

Tests on Dunlop Pneumatic Equipment for Farm Carts, Season 1933-34, *W. Sayer*. Agr. and Livestock in India, 4 (1934), no. 5, pp. 524-533, pls. 16, figs. 1. Tests conducted at the Pusa Research Institute of four sets of wheels, tires, hubs, and axles are reported. The equipment was tested throughout a complete cane carting season.

The tests showed that the loads which could be drawn over the same surface were much heavier with pneumatic wheel equipment than those which could be drawn in the ordinary farm cart. The power requirement also was less per unit of load. It appears that the use of pneumatic wheel equipment will cheapen cartage costs on cane.

A Quantitative Study of Certain Factors Affecting Soil and Water Losses as a Logical Basis for Developing Practical Methods of Erosion Control, *G. W. Musgrave*. Amer. Geophys. Union Trans., 15 (1934), pp. 515-521. In a contribution from the USDA Bureaus of Agricultural Engineering and Chemistry and Soils data are presented which were obtained from experiments on Marshall silt loam soil, which is extensive and typical of the soils of the Missouri Valley.

Results indicate that the primary factors determining the design of erosion control measures are those affecting (1) the infiltration capacity of the soil, (2) the capacity of the surface storage reservoir, and (3) the group of factors affecting the density of the run-off material. While the infiltration capacity is largely determined by the inherent qualities of the soil, definite improvement may be effected, for example, by incorporation of organic matter, by attention to the character and condition of the vegetative cover, etc. The capacity of the surface storage reservoir may be modified within limits by tillage practices and by terracing. An extremely potent factor affecting the density of run-off is the type of vegetative cover. The density of run-off in turn is a most potent factor in determining the total amount of erosion. All of these factors may be quantitatively determined and from such information the basis laid for a sound system of erosion control under field conditions.

Agricultural Engineering Investigations at the Nebraska Station Nebraska Sta. Rpt. [1933], pp. 5, 6. The progress results are briefly reported of tractor testing, of investigations on wind-driven electric plants for farm use, pump irrigation, electric power on Nebraska farms, efficiency of tractor lugs, methods of cooling milk on farms and their effect on quality, and the adaptation of pneumatic tires to farm tractors, and of a survey of farm machinery.

The Practical Problems of Corrosion—VIII. The Inhibitive Action of Certain Pigments on Rusting, *K. G. Lewis* and *U. R. Evans*. Jour. Soc. Chem. Indus., Trans., 53 (1934), no. 4, pp. 25T-33T. The results of a series of studies conducted by the Department of Scientific and Industrial Research of England are reported. These related to the effect of commercial pigments in tubes containing air and of pure chemicals in tubes containing oxygen. Data were obtained on the effect of pigment in a paint coat scratched locally.

It was found that paints can protect either by mechanically excluding corroding influences or by chemically inhibiting the corrosion reaction. The results indicate that the inhibitive action of pigments rests on the same principles as inhibition by soluble chemicals used in water treatment. When the products of incipient corrosion are precipitated in physical contact with the metal the attack stifles itself and the metal remains immune.

Terracing in a Land-Use Program, *S. P. Lyle*. U. S. Dept. Agr., Bur. Agr. Engin., 1934, pp. 5. In a brief mimeographed contribution from the Bureau of Agricultural Engineering, the importance of terracing in connection with the development of a sound land-use program is presented.

Report on CWA National Survey of Rural Electrification, *G. W. Kable* and *R. B. Gray*. U. S. Dept. Agr., Bur. Agr. Engin., [1934], pp. 68, figs. 3. This mimeographed contribution from the Bureau of Agricultural Engineering describes a survey undertaken as a supplement to the CWA farm housing survey. The purpose of the survey was to obtain information relative to the present availability of electric service to farmers, its use, and the possibility of extending service to additional farms. Twenty-five states were included in the survey.

The data in general indicate that Michigan has led the country for several years in the number of farm customers added to those receiving service. The average farm rate of 4.6 cents per kilowatt-hour for 1932 is reported to be the lowest for any state east of the Mississippi River. *(Continued on page 380)*

Agricultural Engineering Digest

(Continued from page 378)

COOLING MILK ON THE FARM WITH SMALL MECHANICAL OUTFITS, *R. P. Hotis* and *J. R. McCalmont.* U. S. Dept. Agr. Circ. 336 (1934), pp. 24, figs. 8. This circular presents and discusses the results of a study made on 44 dairy farms in Maryland and Virginia where mechanical equipment for milk cooling, using electricity as power, had been installed. The amount of milk handled ranged from 15 to 200 gal per day per farm. Data were obtained on methods of arrangement and operation, power consumption, cost of equipment and repair, and efficiency of the different outfits in comparison with each other and with equipment in which ice was used.

The results indicate that a refrigerating machine for cooling and storing milk on the dairy farm should be of such size that the compressor will not have to run over 14 hr per day, if efficiency of operation is to be assured.

The average cost of complete outfits on 23 farms was about $7.69 per gallon of milk storage, and the average cost per 10-gal can of rated storage capacity ranged from $48 to $103, the lower cost being for larger storage capacity. The cost of repairs on 19 farms averaged $4.20 per year. The amount of water in the storage tank will vary according to the amount of milk cooled. The amount of coil to use per cubic foot of tank will vary according to the amount of milk to be cooled and stored per 24 hr, the range of temperature through which the milk will be cooled, the temperature of the well water used through the surface cooler, and the thickness of the tank insulation. Bunched coils are difficult to support rigidly, and ice forms on them easily. Machines running on an average of 9.1 hr per day used less power per gallon of milk cooled and per gallon-degree of refrigeration than machines running on an average of 17.5 hr per day. A well-constructed, well-insulated storage box cooling to capacity should have a refrigeration loss of less than 30 per cent. Home-built tanks observed were as efficient as commercially manufactured tanks, but carried more insulation.

The power consumption is higher with dry-box storage than with wet-tank storage, but lower temperatures are possible with a dry box. Well water used through the upper half of the cooler will lessen the load on the mechanical outfit and allow it to care for more milk.

Cost of power was less than cost of ice. However, no data were available on depreciation, so this factor and interest and repairs are not taken into consideration in this comparison.

Plans are also included for an inexpensive homemade storage tank or refrigerator box, depending on which is to be used with the machine.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE CALIFORNIA STATION. California Sta. [Bien.] Rpt. 1933-34, pp. 16-18, 95-103. A brief description of the soil erosion investigations is given, together with brief progress reports of investigations on farm housing, production structures, designs for dairy structures, crop machinery, use of electricity in farming, and irrigation.

USE OF ELECTRICITY ON NEBRASKA FARMS, 1920-1934, *E. E. Brackett* and *E. B. Lewis.* Nebraska Sta. Bul. 289 (1934), pp. 47, figs. 36. A report is presented of investigations of the use of electricity on Nebraska farms over a 12-yr. period. Over 60 different uses for electricity were found, of which 40 were fairly common.

The principal uses other than for lighting were for refrigeration, pumping water, laundering, radio operation, cooking, dairy practices, irrigation pumping, feed processing, poultry equipment operation, hay hoisting, grain elevating, cold storage, water heating, soil heating, animal clipping, and general motor belt work.

Data on distribution of usage in amount and time indicate no very abrupt change in the amount of electrical energy used by average Nebraska farmers either month by month or season by season. It also appears that where the investment could be undertaken for the wiring installations and the necessary appliances and equipment, enough energy was consumed to make these farmers good patrons to distributing systems. A few feeders and dairymen in the State use 800 to 1,500 kwh per month regularly, but the number of these specialists is small in comparison with others using rural electric service.

Data on electric refrigeration in rural homes indicate that 0.25 kwh per day per cubic foot of storage should be about the maximum average energy consumption under heavy farm usage during the summer months.

Electrical energy requirements for washing the clothes of the average family of 5 to 6 persons vary from 2 to 4 kwh per month, with the average about 2.5 kwh. With careful operation, the improved washing machine can be relied upon to use less than 2.5 kwh per month if the family is no larger than 6 persons.

It was found that the ironing machine completed the ironing of the same size and type of washing in less than one-half the time required by the electric hand iron. The electric energy required was less in some instances for the ironing machine than for the hand iron. It was also found that the ironing required 6 to 20 kwh per family per month, or 1 to 3 kwh per person per month, with an average of about 1.5 kwh per person per month. These data held for both the machine and the hand iron, with a possible slight advantage for the machine.

The energy consumption of the electric range as used in Nebraska varies from 25 to 50 kwh per person per month, with an average of about 30 kwh. This energy consumption is influenced by the type of cooking, the training and carefulness of the operator, and the quality and adaptability of the electric range.

The consumption of electrical energy about the dairy farm, whether large or small, is distributed evenly over the different months of the year and the hours of the day in such manner that practically all the electrical distributing agencies in Nebraska are glad to make extra effort to give that service. The uses to which the dairyman, or even the farmer who milks several cows as a side line, can put electrical equipment are of such nature that benefits can be readily seen.

An appendix lists manufacturers cooperating in the study.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IOWA STATION. Iowa Sta. Rpt. 1934, pp. 37-43, figs. 2. The progress results are briefly presented of an economic and engineering study of corn production methods in Iowa conducted by J. B. Davidson, E. V. Collins, and W. G. Murray in cooperation with the USDA Bureau of Agricultural Engineering, and of investigations by H. Giese on farm building losses due to wind and fire and on the all-masonry barn, by Collins on the use of tractors, by Davidson and Collins on tractor wheel efficiency, by Collins on the development of equipment for checkrowing beets, by Davidson on harvesting alfalfa with windrow pick-up baler, by Collins on the development of a new type of terracing machine, and by Davidson, Collins, and P. E. Brown, in cooperation with the USDA Bureaus of Plant Industry and Agricultural Engineering, on the basin method of planting corn.

AGRICULTURAL ENGINEERING STUDIES BY THE MISSOURI STATION. Missouri Sta. Bul. 340 (1934), pp. 15-21, figs. 4. Data are reported as to plans for a combination milk house and milking room and a machine shed and horse barn, a 3-horse hitch for wagons, and the spacing of tile drains on Missouri soils, all by J. C. Wooley; dairy refrigeration studies, hotbed heating, and electric brooding, by R. R. Parks; power, labor, and machinery costs on 66 Linn County farms and tests of corn planter fertilizer attachments, by M. M. Jones and D. D. Smith; the determination of the efficiency of energy transformations in the horse, by Jones and S. Brody; and the capacity of silos, by Jones and Smith.

LATEST RESULTS OF ENGINEERING EXPERIMENTS AT THE SOIL EROSION EXPERIMENT STATIONS, *C. E. Ramser.* U. S. Dept. Agr., Bur. Agr. Engin., 1934, pp. 11. This is a brief mimeographed contribution from the Bureau of Agricultural Engineering in which the progress results of the engineering experiments in progress at the federal soil erosion experiment stations, conducted mainly in cooperation with several state agricultural experiment stations, are presented.

It is pointed out that experiments designed to improve the practice of terracing constitutes the major part of the investigations. It is considered evident from a summary of the results that terraces should be spaced close enough to prevent the concentration of water and appreciable erosion on the land slope between terraces. Also, the ability of the terrace channel to carry away the run-off water delivered to it during rains of high intensity should be considered.

The data indicate that the control of erosion in the terrace channel can be accomplished to a limited extent by the shape of the channel. The height of the terrace also largely determines the cross-sectional area of the waterway for any particular slope.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE PENNSYLVANIA STATION, *A. W. Clyde, R. U. Blasingame,* and *J. E. Nicholas.* Pennsylvania Sta. Bul. 308 (1934), pp. 9, 10, fig. 1. The progress results are briefly presented of investigations on potato harvester development and on dairy sterilizers.

VERTICAL DRAINAGE, *H. E. Besley.* New Jersey Stas. Circ. 336 (1934), pp. 4, figs. 5. Brief practical information is given on the installation and operation of vertical drains constructed by either boring or blasting. *(Continued on page 384)*

Agricultural Engineering Digest

(Continued from page 380)

ELECTRIC SOIL HEATING, *J. W. Tomlinson.* Bul. Hydro-Elect. Power Comn., Ontario, 21 (1934), no. 10, pp. 339-350, figs. 4. A large amount of information is presented on electric soil heating from a Canadian source, and data are presented from test results in both hotbeds and coldframes and in the greenhouse. It is stated that repeated tests during the winter and spring have shown that surface heating is entirely practical in hotbeds and coldframes. By applying the heat directly at the point where it is most needed, power consumption has been reduced and the need for special insulation and expensive construction obviated.

It is concluded that any hotbed which is well drained, protected from winds, and free from cracks and openings, may be made into a satisfactory electric hotbed by laying electrical soil-heating cable on the soil surface at the time the seeds are planted.

It was found that plants grew in contact with the heating cables without injury. The lead-covered element seems to be reliable, flexible, and durable, and its heat flux of 5.7 watts per lineal foot is ideal where 100 watts per square yard are used. One of the methods of saving power in any type of electrically heated hotbed is to cover the beds at night. It is pointed out that further information is needed on the proper soil and air temperatures required for various plants at various stages of growth and on the proper electric capacity to maintain good growing conditions under different weather conditions.

A LOW-CUTTING SLED CORN CUTTER, *O. K. Hedden.* U. S. Dept. Agr., Misc. Pub. 212 (1934), pp. 10, figs. 16. A low-cutting sled corn cutter is described which was devised to reduce the labor of gathering the stalks for ensiling or other use where the use of a binder is not practicable. A bill of materials required to construct a 2-row cutter of this type is included.

THE BARREL SEED SCARIFIER, *W. M. Hurst, W. R. Humphries,* and *R. McKee.* U. S. Dept. Agr. Leaflet 107 (1934), pp. II + 5, figs. 2. A homemade scarifier developed by the USDA Bureaus of Agricultural Engineering and Plant Industry is briefly described which has been found suitable for use in scarifying small lots of seed on farms.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only society members in good standing are privileged to insert notices in the "Positions Wanted" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Position Wanted" section. Notices in both the "Positions Wanted" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested.

POSITIONS WANTED

AGRICULTURAL ENGINEER, technical graduate with additional M. E. training, 3 years of experience, desires position in testing and development work for machinery manufacturer, or research and teaching farm power and machinery and land reclamation in state university. Now employed. PW-263

AGRICULTURAL IMPLEMENT SALESMAN, college trained, age 32, married, born and reared on midwestern farm, 7 years experience operating territories in the New England states for a large implement manufacturer, desires similar position in Middle West with large full line implement manufacturer or jobber. Now employed. PW-264

POSITIONS OPEN

EXTENSION AGRICULTURAL ENGINEER wanted in one of the states of the Southwest. Duties will include attention to problems of soil erosion, farm and community buildings, and some housing and home equipment. A man around 30 to 35 years of age preferred, with degree in agricultural engineering, some experience in vocational teaching, extension, college, or applied commercial work, who has good judgment and can meet and work with people well. Salary will depend on qualifications—probably about $3000.00, with chance for permanent work. PO-107

JUNIOR ENGINEER. The U. S. Civil Service Commission announces an open competitive examination for the position of "junior engineer" in several branches of engineering, including agricultural engineering. Applications must be on file with the Commission at Washington, D. C., not later than September 16. Application Form 8, copies of which may be obtained at any first-class postoffice, should be used in filing application for this examination.